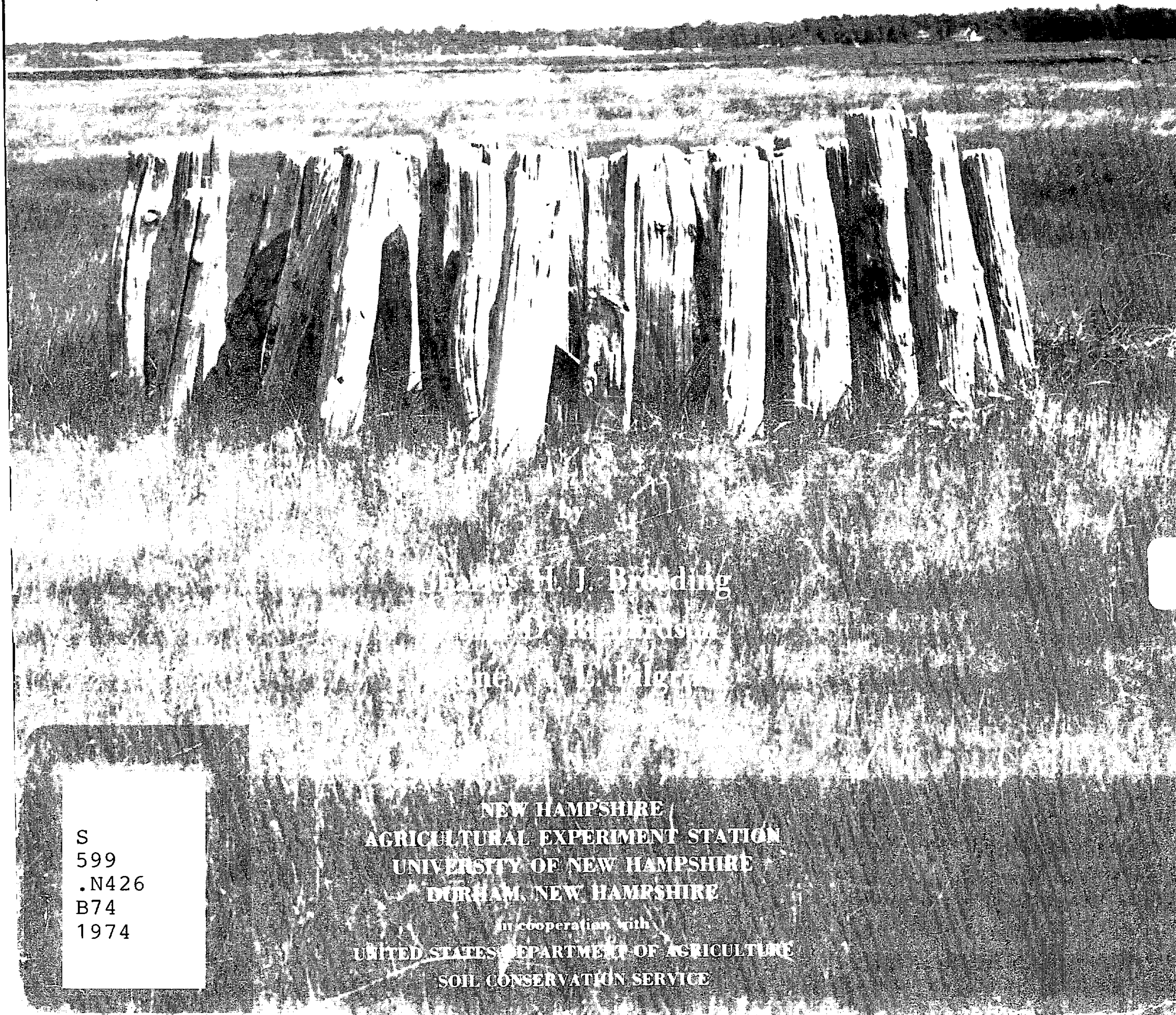
Research Report Number 40
October, 1974

SOIL SURVEY OF NEW HAMPSHIRE TIDAL MARSHES



by

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in cooperation with

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

HOW TO USE THIS SURVEY

This survey contains information that can be useful in evaluating the suitability of tracts of tidal marsh for community and commercial development, light industry, and for recreation, farming and wildlife habitat. Information for engineering uses such as roads, buildings, shallow excavations and other purposes is also provided.

Locating Soils

All the soils of the New Hampshire tidal marshes are shown on the detailed map at the back of this publication. This map consists of many individual sheets made from aerial photographs. An index map to the individual sheets is provided to assist in locating a specific sheet. Numbers on the index map refer to individual soil sheet numbers. On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is generally inside the area; however, for small areas it is outside and a pointer is used. The user should note the map symbol for the area of interest. The soil name can then be obtained from the Soil Legend located with the individual sheets. The Table of Contents is a useful reference for locating information by map symbol or named soils. Users will note that separate listings and page numbers are provided for both soil descriptions and soil interpretations.

Finding and Using Information

The "Table of Contents" lists all the soils of the tidal marshes in numeric order by map symbol. It also gives the page number for each soil description. Most users will refer only to the more generalized mapping unit descriptions for a discussion of soils. For community planners, engineers, builders and others, the characteristics of each mapping unit as they affect town and country planning, recreational development, farm use and specified engineering uses are discussed in the section on Soil Survey Interpretations. Interpretations for each mapping unit are provided in this section. Also, the estimated physical and chemical properties for engineering are given. Additional chemical and physical properties of tidal marsh soils are listed in Tables 1 through 5.

Soil Scientists and others interested in the classification of soils can read the sections on Classification of Tidal Marsh Soils, Descriptions of the Soils and Characterization of Soils.

Botanists and others particularly interested in the plants associated with tidal marshes can read the section on Tidal Marsh Vegetation and Appendix A, Annotated Species List of Vascular Plants for New Hampshire Tidal Marshes and Dune Areas.

For the general reader and others interested in tidal marshes the Introduction and the sections How This Survey was Made, and Tidal Marsh Formation, can be read.

ACKNOWLEDGMENT

The authors wish to express their gratitude to the following for assistance:

To Gary Miller, graduate student in hydrology, University of New Hampshire, and to Paul D. Hersey and William A. Birtles, students in the Soil and Water Science Department, University of New Hampshire, for their assistance in field work. Mr. Hersey also assisted in the collecting of soil samples and analyzed the samples for salinity and pH. To members of the New Hampshire Soil Conservation Service Soil Survey Staff who assisted in documenting mapping units and reviewing the manuscript. To Dr. Albion R. Hodgdon, Professor of Botany, University of New Hampshire, who provided support and encouragement throughout the project and valuable assistance in plant species determination and interpretation of vegetational communities. To David N. Allan, Biologist, Soil Conservation Service, for his aid and advice, and especially for his diagrams and illustrations.

The field work and supporting laboratory assistance were funded in part by a grant from the New England Regional Commission through the New Hampshire Office of Comprehensive Planning and the Southeastern and Strafford Regional Planning Commissions. This soil survey was also financially supported by the New Hampshire Agricultural Experiment Station and USDA, Soil Conservation Service, and endorsed by the Rockingham County Conservation District.

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SUMMARY STATEMENT

For the benefit of the casual reader who is interested in obtaining only general information about tidal marsh soils, the following discussion is presented. Any use of this summarization as a basis for land use recommendations should be avoided; for such uses the full text, tables and soil maps should be consulted.

The tidal marsh soils form on deposits of sand or silt or both. As the surface of these deposits, which build up only in quiet protected waters, approach the level of high tide, certain grasses establish themselves. The stems and roots of these grasses trap and hold sand and silt particles. The periodic flooding of tidal waters allows only a partial decay of the plant remains so that the tidal marsh soil is a mixture of organic and mineral components with characteristic physical and chemical properties. Among the more important qualities of most New Hampshire tidal marsh soils are: (1) an inability to support heavy loads, (2) the release of sulfur in acid form upon prolonged exposure of the soil to air and (3) daily tidal flooding.

This combination of qualities severely limits many uses of tidal marsh soils. Daily tidal flooding and the inability of the soil to support heavy loads presents limitations to the building of roads and other structures on marsh soils. Draining and diking the marsh soils creates conditions for the formation of acid which has a potential to corrode metal and concrete materials. Without extraordinary precautions or expensive control measures or both, the tidal marsh soils are best suited for limited recreational use and as natural habitat for a variety of aquatic and terrestrial plants and animals, many of them unique to this ecosystem.

SOIL SURVEY

of

NEW HAMPSHIRE TIDAL MARSHES

by

Charles H. J. Breeding, Frank D. Richardson,
and Sidney A. L. Pilgrim[1/]

INTRODUCTION

The tidal marshes of New Hampshire lie in the southeastern corner of the State occupying an area of approximately 7500 acres. The bulk of these marshes comprise those in the towns of Seabrook, Hampton, Hampton Falls, North Hampton, and Rye, having formed along the seacoast in embayments protected from the direct force of the sea. The remaining tidal marshes are strung in coves and shallows along the margins of Great Bay and the complex of tidal streams and rivers flowing into it (Fig. 1).

While various accounts have been written about these marshes, no detailed study of New Hampshire tidal marsh soils has been made, previous maps and descriptions having made no differentiation of soils within the overall tidal marsh area.

This soil survey includes a description of the tidal marsh soils, their classification, and their delineation on aerial photographs of the marsh area. Tidal marsh vegetation and its relation to the soils and tidal

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marsh formation is reviewed in considerable detail. In view of the pressures on this unique ecosystem, the authors deemed it advisable to present soil survey interpretations for various uses of the tidal marshes. The interpretations provide useful data to individuals, local and state agencies, and others involved in making land use decisions.

From the European settlement of the New England coast until the early 19th century, the tidal marsh provided valuable hay and pasturage to seacoast farms. During the 19th century, efforts were made to improve the production of the marshes, principally by diking, but in New Hampshire none were successful and the marshes remained essentially in their original condition. Over the years much of the tidal marsh was ditched to promote more rapid drainage of standing water and to control mosquitos. Even today, in other sections of the Northeast, the fine salt meadow grass, Spartina patens, is cut, cured and sold as "salt hay", some for livestock feed but most for mulch. However, there is now no commercial use of New Hampshire tidal marshes for pasture or salt hay. Those interested in descriptions of haying methods and related topics see the accounts of Wells (1911), Townsend (1913), and Jewett (1949); for a comprehensive study of tidal marsh history, development, ecology and conservation, see Teal and Teal (1969).

In this report the term 'tidal marsh' is used since it best describes the entire system that we are treating. While often synonymous with 'salt marsh', the term 'tidal marsh' more appropriately includes only those areas influenced by the tidal regime, from saline to brackish, thereby eliminating consideration of any saline or brackish marsh not associated with the tides.

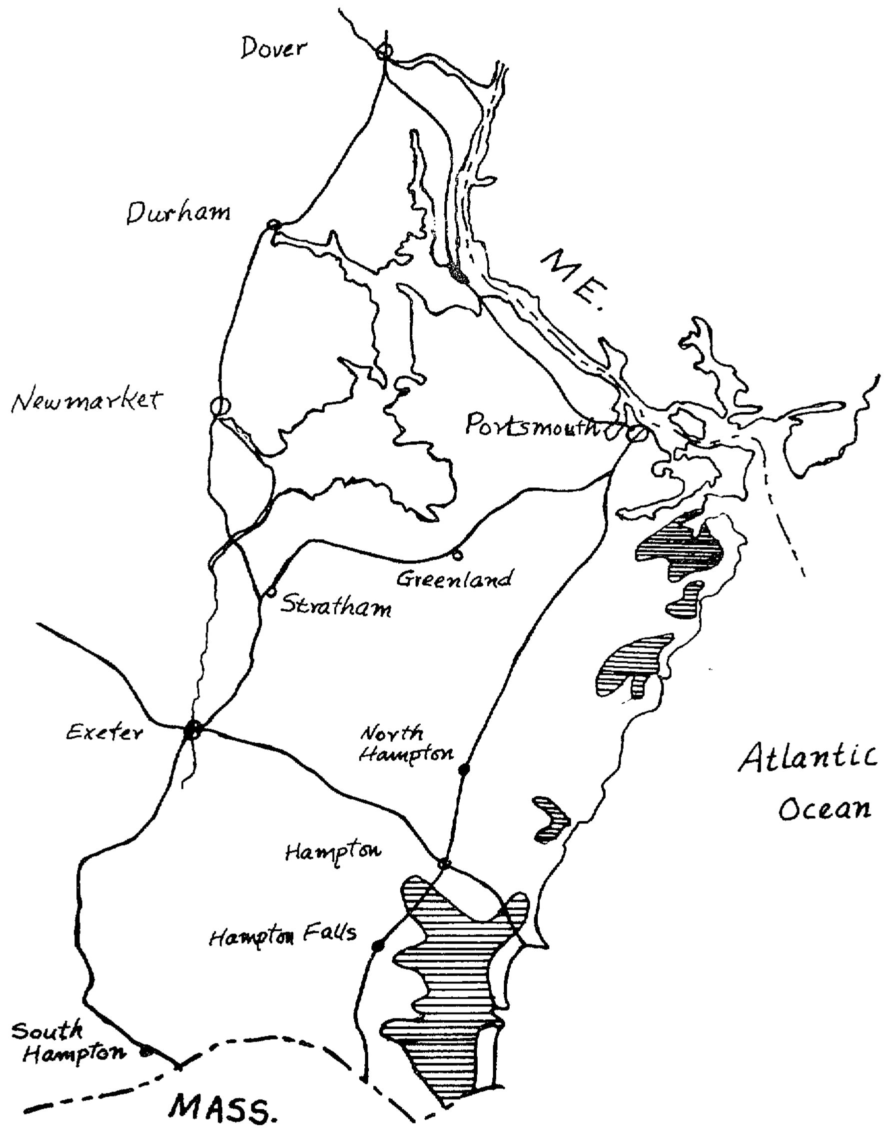


Figure 1, Generalized location map of major coastal tidal marshes in New Hampshire (not to scale).

In any report of tidal marshes it would be difficult to ignore the animal life. No one of the authors felt competent to discuss this important part of the tidal marsh ecosystem. Therefore, we included the following brief discussion.

> "The tidal marsh is an extremely dynamic ecosystem. As a natural system it is constantly subject to all the changing forces of nature. The constant interplay of tidal action, changes in salinity, storing and releasing of nutrients or food energy make it one of the more productive areas on earth. Scientists report an overall ecological life-support value of about $4,000 per acre per year. This is based on the estimated production of 24 million calories per year that are available as nutrients in northern marshes. The sea of grasses covering the marsh, floating phytoplankton, seaweed algae plus the film of 'mud algae' such as diatoms, flagellates and blue-green algae, are the primary energy producers.
>
> Marine animals are restricted to those that can adjust to rapid salinity changes. Most organisms follow the ebb and flow of tides over the marsh. The estuaries and tidal streams support many crustaceans; barnacles, shrimp, and green and hermit crabs are plentiful. While not a true crab, the horseshoe crab is an interesting relic of a prehistoric time that returns each spring to spawn. Soft-shelled, razor and surf clams, mussels and snails are abundant mollusc representatives.
>
> The periwinkle snails graze the marsh throughout the intertidal zone. Marsh snails may remain in the drier salt meadow. About 60 species of fish frequent the tidal streams but the true marsh inhabitants are the hardy mummichog and the stickleback. These fish live in the pannes and pondholes under inhospitable conditions of low oxygen, high salinity and extremes of temperature.
>
> Many birds of eastern United States may be found on the marshes, especially during spring and fall migration, but few species are true marsh inhabitants. The sora, black duck, blue-winged teal, bittern, certain shorebirds, marsh sparrow, red-winged blackbird and marsh wren are marsh dwellers. Herons are common and the marshes have recently been invaded by egrets and glossy ibis. In late summer and early fall the marshes and tidal flats are alive with shorebirds, flashing white wings as they fly in unison; their plaintive cries are the lonely voice of the marsh. Muskrats are permanent residents. Meadow mice live along the edge of the high marsh. Raccoon, red fox and deer inhabit the uplands but feed in the marshes." 1/

1/ By David N. Allan, Field Biologist, Soil Conservation Service.

TIDAL MARSH FORMATION

The New Hampshire tidal marshes are typical of what has been called the "New England type" (Johnson 1925). The development of this type of marsh is dependent upon the post-glacial submergence of the land or the concurrent rise in sea level, or both. The formation begins with the accumulation of sediments protected from the direct force of the sea. The sediments may be deposited in sinking stream or river valleys in which tidal waters flow, i.e., estuaries, or in lagoons or embayments shut off from the sea by sand bars or barrier beaches formed by tidal action. These sediments are primarily of marine origin but are supplemented by silts and sands carried in by streams from the adjoining uplands.

The sediments increase in depth until they reach the level of mid-tide. Then vegetation begins with the establishment of *Spartina alterniflora* - (salt water cordgrass). As stands of this grass spread and thicken, additional sediments are trapped and build up at a faster rate. The accumulation of very slowly decaying layers of plant residue on and in these sediments, below the level of high tide, is the intertidal marsh. When the level of mean high tide is reached, *Spartina alterniflora* is replaced by *Spartina patens* (salt meadow grass) and other salt-tolerant species and the high marsh - with an essentially flat surface at high water level - is established. This process continues with the resultant expansion of the high marsh until the entire lagoon may become marsh except the channels through which the tidal waters flow and fresh water streams empty.

On the landward side of the marsh, as the sea level rises and gradually floods the fields and forests, the existing vegetation is killed and is replaced by marsh plants, Plant residues and sediments continue to amass

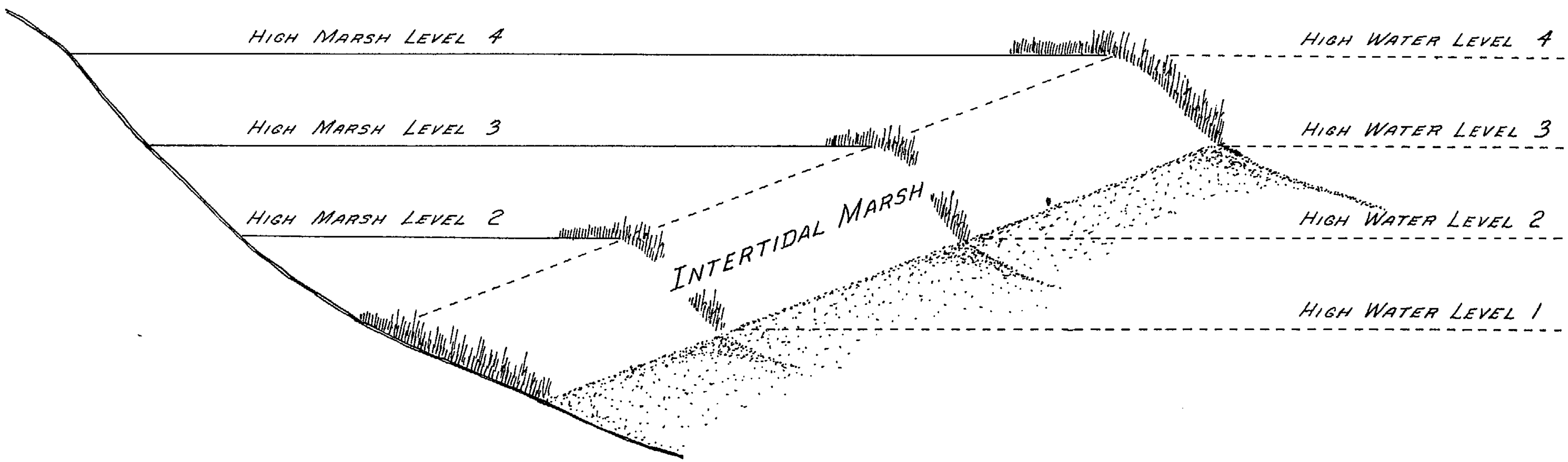


FIGURE 2. THE DEVELOPMENT OF INTERTIDAL MARSH AND HIGH MARSH AT SUCCESSIVE STAGES UNDER A RISING SEA LEVEL. (AFTER REDFIELD. A.C. AND M. RUBIN. 1962)

and the high marsh slowly encroaches on the land.

In the estuaries, a similar process occurs, but the sediments are more likely to be silts with fewer sands, and the intertidal and high marsh both form in relatively narrow bands along the larger streams. In the flooded valleys of the smaller streams and in shallow coves of inland bays, more extensive areas of high marsh form, but do not approach the coastal marshes in size.

Those interested in a more comprehensive discussion of tidal marsh formation are referred to Teal and Teal (1969) and Redfield (1972). The history of the theory of tidal marsh formation may be studied in Mudge (1858), Shaler (1896), Davis (1910) and (1911), Johnson (1925) and Redfield (1965) and (1972). Chapman (1960) describes tidal marshes world-wide.

The formation of tidal marshes on a glaciated coastline, such as New Hampshire's, is dependent upon the process of sedimentation, the long term changes in sea level relative to the land, the vertical range of the tidal regime, and the physiology of the vegetation (Redfield 1972). The interaction of these components on the local terrain determines the nature of a particular tidal marsh (Fig. 2).

Keene (1971) has summarized the data on the submergence of the New England coast which establishes its beginning 6,000 to 7,000 years ago. For the first 3,000 years of that period, the rate of submergence was 7.7×10^{-3} ft/yr and in the following 4,000 years it has slowed to an average 3.7×10^{-3} ft/yr, or roughly 4 inches per 100 years. Sedimentation has taken place concurrently.

Sampling by Keene (1970) and the Public Service Company of New Hampshire (1971) in the large Hampton-Seabrook marsh shows bedrock and glacially deposited materials covered by post-glacial sediments increasing in thickness from the landward to the seaward side of the marsh. At the base of these sediments is a thin layer of identifiable organic material, primarily forest litter, with an admixture of herbaceous plant remains. The authors' investigations showed woody fragments, logs, and tree stumps at the base of the sediments near the landward margin of the marsh, further indicating the encroachment of the expanding marsh into adjoining wooded uplands.

The mineral sediments of sands, silts, and clays grade upward into fibrous peat. These peat deposits are thickest near the center of the basin and become thinner toward the landward and seaward sides of the marsh and as they approach the major tidal channels (Fig. 3). Peat deposits are generally less than 15 feet in depth, with the deepest deposits located along sunken valleys and stream channels. Peat samples taken by Keene (1970) for radio carbon dating ranged from 11.2 m. in depth, age 6850 $\pm$ 155 years to 2.0 m. in depth, age 2740 $\pm$ 310 years. These samples were taken on a transect across a buried river valley in the Taylor River marsh in Hampton.

The tide is a controlling factor in the establishment and growth of marsh plants. The mean tide range at Hampton Harbor is 8.3 feet. A mean high tide covers most of the high marsh but the higher elevations are covered only during spring tides when the range is 9.5 feet. This difference in flooding can be observed in vegetational changes, e.g., *Juncus gerardii*, black grass, is more common on the higher sites.

The mean tide level at Hampton Harbor is 4.1 feet and at this point, the so-called half tide mark, vegetation generally appears. It is on those areas between mean high tide and mean tide, either the escarpments along the tidal channels or the flats below the level of the high marsh, that

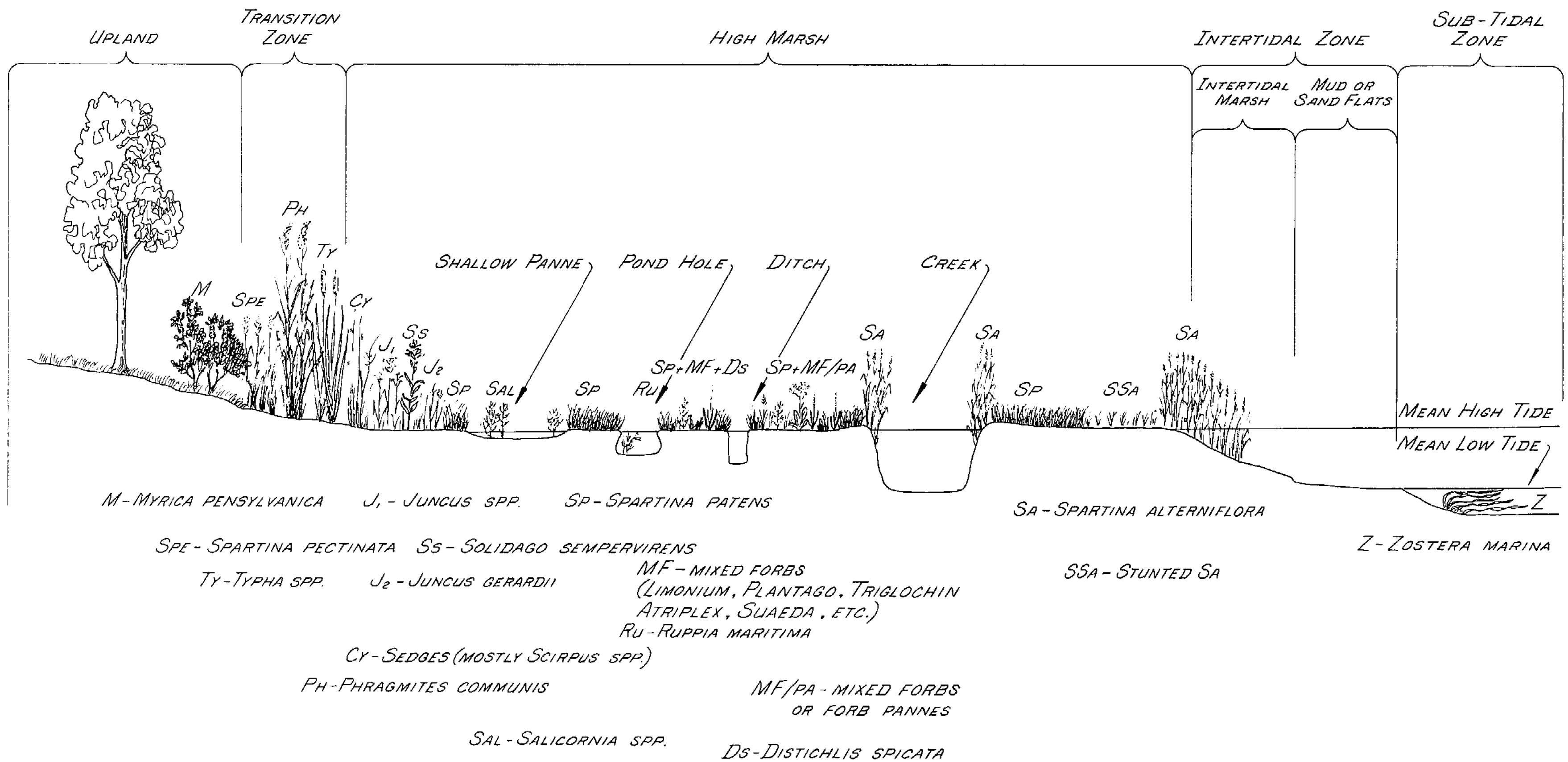
Spartina alterniflora is the dominant vegetation. Even as far inland as at the railroad bridge over the Squamscott River at the upper end of Great Bay, the mean range is 6.8 feet and the spring range is 7.8 feet with a mean tide level of 3.4 feet, so that essentially the same limits prevail.

TIDAL MARSH VEGETATION

The vegetation of New Hampshire tidal marshes is of a surprisingly heterogeneous nature. Those who suppose the tidal marsh to represent a "monotonous expanse of grass" will discover that with only the simplest observations afforded by walking out on the marsh, a variety of shapes, colors, and textures immediately touches the senses. Closer investigation will provide one with the pleasure of discovering plants of a rather unusual appearance when compared with those of the upland. Many are succulent and do not have typical leaves or flowers. Some may appear totally devoid of interest until study with a hand lens reveals intricate design. Very few indeed have the showiness of woodland flowers, but the soft lavender mist of Limonium and the dotted pinks and purples of Gerardia and Sea Milkwort add subtle splendor to the softly waving grasses. The diminutive flowers of the Spartina patens and Distichlis spicata meadows lend a certain harmony to the gently undulating high marsh. In autumn the marsh is ablaze with color. The flaming red Salicornia, the brilliant heads of the Salt Marsh Goldenrod, and along the borders, the tall plumes of Phragmites are a sign of the changing seasons as are the shorebirds which pause briefly to rest and feed in the marsh on their long seasonal migration.

The occurrence and distribution of the plant species in an ecosystem is referred to as the species strategies. The autecological limits of the plant species of a tidal marsh, when considered both individually and in association with other species with regard to environmental factors and species interaction, will give insight to the structure and dynamics of the vegetational community and plant associations. The tidal marsh vegetational community is composed of plant species populations interacting with varying degrees of influence on each other relative to the

FIGURE 4. GENERALIZED DISTRIBUTION OF TIDAL MARSH VASCULAR PLANTS INCLUDING SOME REPRESENTATIVE SPECIES



environmental factors which impose limitations on growth and development. For the purpose of this study, an association simply refers to the occurrence of one species relative to another, within a unit area. The association is not intended to define particular affinities or tolerances, but only the observation that, with some regularity, certain species will grow together often engendering a characteristic of the vegetational community which may be described with some accuracy. Similar associations may provide a basis for comparative studies of different marshes or different portions of a marsh.

As reported by Ranwell (1972), "each species on a salt marsh has evolved its own particular strategy for dispersal, establishment and growth; each has its own dimensional limits of age, height and potential clonal size. Strategies are controlled by the range of the environments in which a species can survive and the kinds of change the environments have undergone in the past and are undergoing now acting on the somatic and genetic material of which the species is composed."

It is beyond the scope of this investigation to present a thorough analysis of all the various aspects of the vegetational community. Rather, we noted characteristic zonation, associations, and distributional patterns of the vegetation which will be briefly described herein (Fig. 4). Additional information regarding individual species is presented in the Annotated Plant Species List (Appendix A). For further information on the structure and function of the tidal marsh vegetational community, the following references are suggested: Chapman (1960, 1964), Redfield (1972), Ranwell (1972), Miller and Egler (1950).

The plant species of the tidal marsh are essentially of two types, annual or perennial. The occurrence and distribution of these species may therefore be described and analyzed in terms of annual or perennial species strategies.

The annuals, which are largely represented by members of the Chenopodiaceae, include Atriplex, Suaeda and Salicornia. The distribution of these plants fluctuates seasonally, within certain limits, and is largely dependent on tidal cycles and the range of spring tides for dispersal. They may occur scattered on the high marsh, in pannes or depressions which provide open situations that annuals will readily colonize, along the banks of creeks or ditches, and along strand lines at the edge of the marsh where the tides have deposited seeds or young seedlings. The latter frequently germinate while still floating and subsequently become lodged in debris at the upper reaches of the tide.

The dominant vegetation of the tidal marsh is the perennial grasses, the Spartinas. Two other perennial grasses which are frequent to abundant on New Hampshire marshes are Distichlis spicata and Puccinellia maritima. To a lesser degree other perennial graminoids including rushes (Juncus) and sedges (Scirpus) inhabit more localized regions of the marsh or the transition zone at the edge of the marsh. Other perennials, which are either scattered over the marsh or concentrated in forb pannes, include Limonium, Plantago and Triglochin. The evolution of the perennial species strategy of the tidal marsh is a fascinating topic of discussion. Questions concerning the ontogeny of a tidal marsh frequently focus on this subject. Many interesting theories have been put forth in the literature. The references cited earlier should be consulted for more in-depth discussion.

Perennial species, both the living plants and the accumulation of dead parts, are the binding and consolidating material of which the tidal marsh is composed. The very substance of the marsh, the peat, is a composite of sediments and organic material, the latter being almost entirely composed of the remains of perennial grasses further bound and stabilized by the roots and rhizomes of their progeny or successors. When one considers the seasonal changes on the New Hampshire tidal marshes, it is quite obvious that if it were not for the tenacity with which this material is bound, the shearing and grinding effects of winter ice flows would surely destroy the marsh or, more likely, would never have allowed one to develop. Since the growing tips of the grasses are at the nodes and apices of subterranean rhizomes, they are protected even if the surface is thoroughly scoured by ice movement.

Annual species do little to perpetuate an ecosystem of such severe environmental stress. Instead, they are secondary components of the vegetational community which add to the stability of the ecosystem by contributing to its diversity. The annuals are dependent on seasonal seed production and dispersal; their occurrence and distribution will reflect fluctuations of the seasonal environment. The annual species strategy is therefore influenced by (1) physiologically limiting factors such as light, temperature, moisture, salinity and nutrients, and (2) by the distributional factors previously mentioned.

The perennial species, Spartina alterniflora, is the first to colonize the intertidal zone, i.e., below mean high water level. It may initially develop from seed on tidal flats or unvegetated areas on the marsh, provided the environment is conducive to seed germination and establishment of seedlings. Although newly exposed mud flats may continue to be colonized by seedlings, most of the spread of vegetation is clonal (Fig. 5). Vegetative propagation, either by rhizomatous growth or the transport of pieces of rhizomes to new sites, is the strategy employed by the perennial grasses to assure continued growth and development. Some species such as Phragmites communis have become so specialized in their mode of vegetative propagation that viable seed is rarely produced.

The development of intertidal vegetation consisting almost exclusively of Spartina alterniflora hastens the rate of accretion of sediments, the primary condition necessary for the formation of tidal marsh peat. The first formed peat, the intertidal peat, has an entirely different nature than the high marsh peat. Around the bases of the Spartina alterniflora plants, two species of brown algae, Fucus vesiculosus var. spiralis and Ascophyllum nodosum f. scorpiodes, are commonly found. This tangle of algae helps to trap the sediments which are carried over them by each tide. The finer sediments associated with the high marsh peat do not accumulate in the intertidal region except when trapped in pools and meanders of creeks and ditches where the velocity of flow is slowed enough to allow for deposition. During the winter season, ice flows and wave action shear off a large portion of the Spartina alterniflora culms at their bases leaving only the perennial rhizomes in the mud. The following season new plants will develop from the rhizomes and the process of accretion will continue. This is not to say that accretion does not occur during the winter, but it seems apparent that it is more significant during the growing season. Certainly, this is an area where more study is needed. Since a large percentage of the aerial parts of the plants is not incorporated in the intertidal peat, this soil is generally of coarse structure with a low volume of organic matter.

During the process of development of the intertidal peat the living conditions which were present at the time of seedling establishment are continually changing due to accretion and soil maturation. The result of this process is a distinctly different soil environment for the mature, vegetatively-proliferating plants. As the intertidal marsh continues to develop vertically, the dense growth of 3-5 foot tall culms of Spartina alterniflora thins out back from the creeks and ditches as a noticeably shorter form dominates the surface of the outer reaches of the marsh. The surface of this marsh is quite firm and level. The presence of abundant marine algae both of the filamentous and fucoid type, along with snails often found clinging to the bases of the *Spartina* plants, gives evidence that this marsh is still well within the intertidal zone. Although there has been considerable development of peat, as evidenced by marsh banks which have been eroded by wave action (Fig. 6), the composition of the peat accumulation is still relatively low in aerial plant parts. The soil here is quite sandy and the organic matter largely comprises dead roots and rhizomes of *Spartina alterniflora*.

The short form of *Spartina alterniflora* is apparently an ecological variation which develops vegetatively, often over large areas of the marsh, due to environmental factors. The soil-moisture and thermal regimes of the peat, nutrient availability, and salinity may all be influences. However, there is no conclusive evidence on this matter. Teal (1973) and others are presently studying the nutrient movement through tidal marsh peat and other problems which will no doubt lend more insight.

As the surface of the marsh rises to the mean high water level, the intertidal *Spartina alterniflora* is replaced by *Spartina patens*. This replacement is often gradual with the two species growing together forming an association covering large areas of many of the coastal marshes (Fig. 7). An abrupt transition may also occur in which a very distinct zone of *Spartina alterniflora* will abut on the *Spartina patens* meadow. The degree of distinctness of this zonation is attributed to the distance over which the elevation of the marsh surface rises to the level of mean high water. A gradual slope, often nearly imperceptible without the use of a level, will result in a gradual transition of vegetational zones with the Spartina alterniflora - S. patens association occurring on much of the open coastal marsh. A more rapid rise in elevation will create the distinct zonation which is frequently encountered on the estuarine marshes having much narrower, steeper basins.

The Spartina patens marsh is the most characteristic feature of the landscape. The surface is relatively flat with a somewhat undulating effect created largely by the tousled appearance of the grass combined with minor surficial changes in elevation. The dendritic pattern of the natural creeks and channels is contrasted by the rigid geometry of the drainage ditches. Scattered on the coastal high marsh are many staddles. These circular arrangements of posts formerly used for stacking salt hay are still in a remarkably good state of preservation (Fig. 8). Some of the staddles have formed small impoundments thereby initiating the formation of forb panne associations or Ruppia pools (Fig. 9). The vegetation is often a nearly pure stand of Spartina patens dotted with various herbs and perennial forbs. Frequently, a Spartina patens - Distichlis spicata association occurs, the latter species occasionally forming pure stands. Although attempts have been made to analyze this association in terms of environmental factors and correlations with change in elevation, both of which might be rather difficult to distinguish, no convincing evidence can be found as to why Distichlis spicata is distributed in the way it is. The habitat requirements for both species seem to be very similar and no indication of competition for niche can be shown. Puccinellia maritima frequently occurs in scattered clumps on the high marsh and often in nearly pure stands in localized areas along the landward edge of some marshes. Puccinellia maritima seems to occur on the most well-drained parts of the high marsh, but again this observation does not always hold true.

As stated earlier, the high marsh peat is of a distinctly different character than that of the intertidal marsh. This is because a large percentage of the annual biomass or standing crop of vegetation is incorporated into the peat in most all areas of the high marsh. The surface tier of typical high marsh peat is composed of recognizable plant parts, which become gradually decomposed with depth from the surface, a situation somewhat analagous to the humus layer of a forest floor. Fine sediments are trapped by this upper layer and incorporated into the peat. Occasional overwash of coarser material as the result of a storm during a spring tide will create sandy 'lenses' which are readily located with the sounding rod. By pushing apart the culms of a vigorous stand of Spartina patens one will not find the abundance of filamentous algae associated with Spartina alterniflora, due largely to light extinction by the dense cover. Also, the partially decomposed plants of previous seasons evidently do not support algal growth to the extent that the sediment deposits of more open situations do. In open pannes and along the banks or creeks and ditches, the growth of filamentous algae is impressive, often forming thick velvety mats.

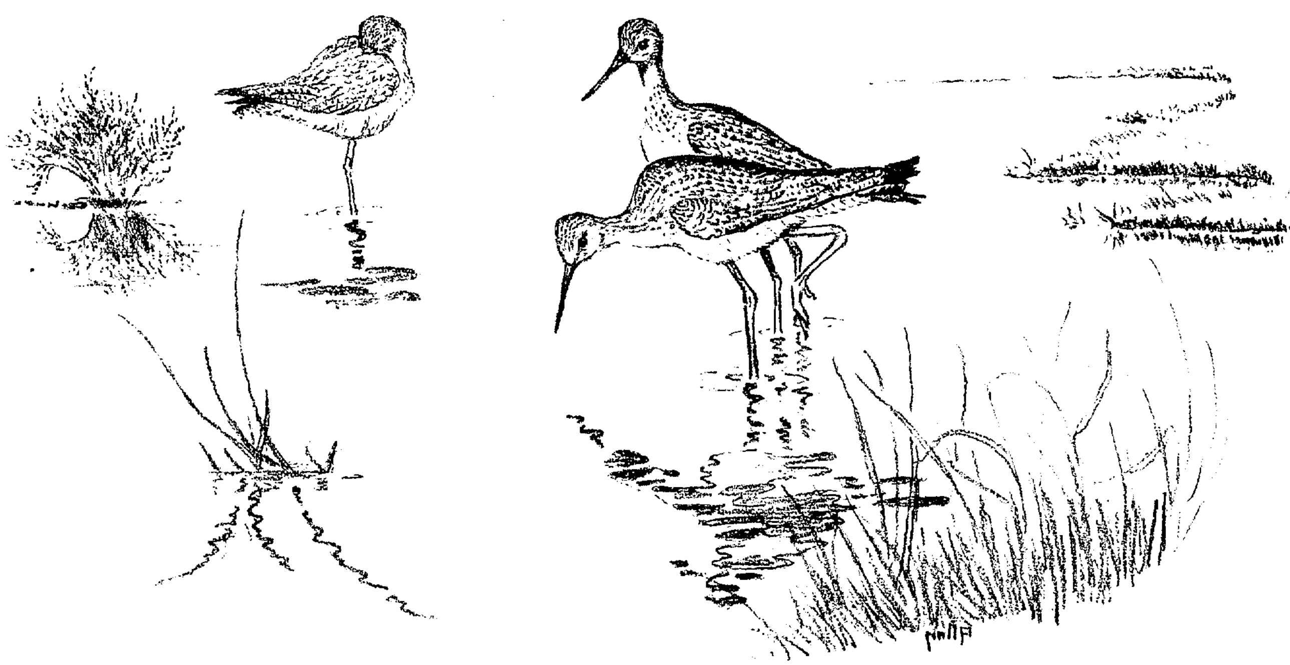
In areas where the high marsh becomes flooded by fewer and fewer tides per year, it seems evident that the growth slows and decomposition of peat proceeds faster than accumulation until the level is again reached where flooding occurs often enough to provide for vigorous growth. Thus a dynamic equilibrium between the salt marsh and the tides is maintained. This statement is admittedly hypothetical and further investigation is needed to test its validity.

The marsh level rises more slowly in areas isolated from the tidal currents by the spread of the vegetation. Levees form along channels where sediments brought in by the tides are deposited among the grasses. Depressions form in the areas isolated from the channels behind the levees. The growth of the marsh slows because of the lessened sediment load. Sea water brought in by the spring tides, rainwater, and run-off from the upland tend to accumulate in areas without adequate drainage (Fig. 10).

Spartina will not grow in areas of continuous soil saturation or standing water. A dwarf form of Spartina alterniflora, even more diminutive than that of the upper intertidal marsh and usually with a yellowish, chlorotic appearance, inhabits some of these areas, but will thin out if water continues to accumulate (Fig. 11). Another factor which may contribute to the sparse vegetation and stunted growth in these areas is the lack of nutrients which are gradually 'filtered out' as the tidal water moves through the peat (Teal, 1973). As would be expected, growth is most luxuriant along the channels (Fig. 12). Another limiting factor is the high salinity in many of the pannes as a result of evaporation of trapped sea water between flooding tides. Few plants other than Salicornia and blue-green algae will inhabit these areas (Fig. 13). In those places where standing water remains, the vegetation will be killed and underlying peat will rot away creating the so-called "rotten spots" (Redfield, 1972). Scirpus paludosus is a characteristic plant in these areas of the marsh. The pinkish color which is quite noticeable in many of these wet pannes is due to the presence of a purple sulfur bacteria. Deep pools known as "pond holes" develop in some places where the peat is decomposed and washed away. As described by Redfield (1972), three different processes which may account for the development of pond holes are: 1) relicts of intertidal pannes, 2) the result of blocking of creeks, and 3) decay of surface peat ("rotten spots"). These will sometimes become quite deep by continuous decomposition of the bottom until the marsh basement is reached. These pond holes are one of the characteristic habitats of Ruppia maritima. Occasionally, rhizomes of Spartina alterniflora surrounding a pond hole will grow out from the sides toward the center, eventually forming a dense 'quaking' mat of vegetation. These unusual formations are especially well developed at Sagamore Creek Marsh, Portsmouth.

It is on the high marsh which initially encroaches on the upland where the Spartina patens - Distichlis spicata association is replaced by other species such as Juncus gerardii. The latter often forms a distinct zone along the landward edge of the marsh. Closer to the upland, a transition zone occurs in which the species density is high. Solidago sempervirens is characteristic of sites receiving adequate drainage, while Phragmites communis, Scirpus robustus and allied species are found in abundance on wetter sites.

Even the most precise experiments attempting to interpret the ecology of tidal marsh vegetation seem to lead to the same conclusions: there exists a series of factors which, under certain conditions on certain marshes at certain times of the year may be interpreted and reported with a certain degree of accuracy. However, the predictability of these results is frequently little more than an educated guess. To present other than specific information based on carefully processed data is likely to entertain severe criticism from more cautious investigators. The literature on tidal marsh formation is impressive and for the most part quite informative although further studies are essential. There is also considerable literature on vegetational distribution, community structure, species strategies, and related topics. In this area also, more study is needed. Special consideration should be given to the autecology of the plant species making up the various associations with particular emphasis on their developmental morphology and physiological ecology.



DESCRIPTIONS OF THE SOILS

In this section, a description of each area shown on the soil map, called a mapping unit, is provided. A symbol precedes the name of each mapping unit; it identifies the mapping unit on the soil map. The reader is urged to read the mapping unit descriptions closely to obtain information on the kinds of significant, unclassified soils that have been included in the mapping unit.

15A Scarboro fine sandy loam, 0 to 3 percent slopes.

This mapping unit consists of very poorly drained, nearly level sandy soils adjacent to tidal marsh soils in the coastal area. The water table is at or near the surface at all seasons of the year. The soil water is fresh or only very slightly brackish. It is not subject to flooding under normal conditions. The one area is less than ten acres in size.

Because of the high water table, this soil is poorly suited to agricultural crops. It is suitable for woodland and wetland wildlife management. Wetness severely limits the use for recreational, industrial, and residential purposes.

Present vegetation consists of reeds, rushes and grasses with some stands of alder, willow and maple.

61B Hollis-Charlton very rocky fine sandy loams, 0 to 8 percent slopes.

This mapping unit consists of shallow Hollis soils and deep Charlton soils. The Hollis series consists of shallow, somewhat excessively drained soils that formed in a thin mantle of glacial till. The Charlton series consists of well-drained loamy soils that formed in thick, stony glacial till. These soils occupy knobs of glacial till underlying the tidal marsh sediments which surface above the level of the marsh, forming "islands" of mineral soil within the marsh area. Rock outcrops are a prominent feature of these islands. Forty to fifty percent of the complex is made up of Hollis soils and forty to fifty percent is Charlton soils. Areas range from one half acre to five acres in size.

Because of the shallow depth over bedrock, the Hollis soils lack adequate moisture for plant growth. Shallowness to bedrock is also a limitation when these soils are used for residential, industrial development or other uses. The isolated geographic location and small size of these areas further limits the usefulness of these soils.

In the present state, these soils are primarily wooded, with a high proportion of white pine and oaks. Woodcrop productivity is fair to good. It has potential for woodland wildlife habitat and for wildlife species associated with, but not living on, the tidal marsh.

397 Typic Sulfihemist, organic materials thicker than 50 inches.

This soil occupies the high marsh of the main central part of the coastal marshes, the high marsh bordering the streams feeding into the coastal marshes, and the high marsh bordering the smaller streams flowing into Great and Little Bays. Areas range from a few acres to 500 acres or more in size.

Included in the mapping are small areas with organic soil materials less than 50 inches thick lying over submerged sandhills in the central marsh and narrow strips with organic soil materials less than 50 inches thick along the margins of the marsh where the mineral soil slopes steeply below the organic deposits. Also included are small outcroppings of bedrock less than one-fifth acre in size. There are also small areas of less than an acre in extent that occupy the margins of the marsh and the upper reaches of small streams where the flow of fresh water makes the surface soil materials less saline.

The periodic flooding by tidal sea water, the slow internal drainage, and the sulfide content are principal problems to management. The saline nature of the soil further limits vegetation to those plants capable of standing high concentrations of salts.

In its natural state, this soil is suited for the growth of halophytes such as Spartina patens and Juncus gerardii. Salt hay appears to be the only agricultural crop; the land is presently idle. Flooding and salinity preclude use of this soil for tree growth. Restricted internal drainage, flooding, and low bearing strength present severe limitations to its use for community development. It is well suited to wetland wildlife habitat development.

497 Terric Sulfihemists over sand, organic materials 16 to 50 inches thick overlying sandy materials.

This soil generally lies at the edges of the high coastal marshes, both the landward margin underlain by sandy-textured tills and the seaward margin underlain by the sands and gravels of the barrier beaches. It also lies in a band on each side of the large tidal rivers of the coastal marsh. Most of the intertidal marsh, including the islands separated from the main body of the coastal marsh by channels, also comprises this soil. Areas range from a few acres to fifty acres in size.

Included in the mapping are some areas with organic soil material 16 to 50 inches in thickness over silt and some areas with organic soil material more than 50 inches in thickness. There are also several small areas of rock outcrop less than one half acre in size.

The major management problem is the periodic flooding by sea water. The high water table, salinity, and sulfide content of this soil present additional problems.

The natural vegetation of the intertidal portion of this soil is uniformly Spartina alterniflora, salt water cordgrass. The high marsh vegetation comprises a greater variety of salt-tolerant herbaceous plants with the dominant species being Spartina patens, salt meadow grass; Distichlis spicata, spike grass; and Juncus gerardii, black grass. Only the high marsh areas afford any potential for farming and that is limited to production of salt hay. Ditching has hastened the removal of standing surface water and encouraged the spread of Spartina patens into such areas. This soil does not support tree growth.

This soil has severe limitations to use for community and recreational development. It is best suited to wetland wildlife habitat development.

597 Terric Sulfihemists over silt, organic materials 16 to 50 inches thick overlying silty materials.

This soil occupies high marsh areas along the upper reaches of streams feeding into the Great Bay complex, shallow coves and narrow margins of the bay, and the intertidal marshes contiguous to deep high marsh soils of the bay. It is also on the headwaters of small tidal streams and in small coves on the landward side of the coastal marshes. Individual areas are 2 to 15 acres in size.

Included in the mapping are small pockets of soil where the organic soil materials are more than 50 inches in thickness and some areas where the mineral horizons are interbedded sands and silts rather than fine and medium sands. Also included are several rock outcroppings less than one-fourth acre in size.

The chief management problem of this soil is its periodic flooding by tidal sea water. Major factors presenting additional problems are salinity, restricted internal drainage, high water table, and the presence of sulfidic materials. The ditching installed in many areas, in part as a mosquito control measure, has facilitated the removal of surface waters but has not increased the potential of this soil for other than its present use.

The dominant natural vegetation is <u>Spartina alterniflora</u>, salt water cordgrass, on the intertidal marsh and, on the high marsh, <u>Spartina patens</u>, salt meadow grass; <u>Distichlis spicata</u>, spikegrass, and <u>Juncus gerardii</u>, black grass.

The salinity and periodic flooding preclude tree growth and the growth of herbaceous plants other than those capable of standing salt concentrations in excess of 10,000 ppm.

This soil has properties that make it unfavorable for community and recreational development uses. It is not suitable for farming. It is well adapted for use as wetland wildlife habitat development.

697 Lithic Sulfihemists, organic materials 16 to 50 inches thick overlying bedrock.

This soil occupies areas characterized by numerous rock outcroppings. It occurs in the eastern part of the town of Rye and in one small area in the town of Seabrook. Areas range from 1 to 10 acres in size. Included in the mapping are soils with organic soil materials more than 50 inches in thickness lying in pockets between the more resistant, vertically-inclined, underlying bedrock and soils with organic soil materials 16 to 50 inches in thickness over sands and gravels. Also included are scattered rock outcrops less than one-fourth acre in size.

This soil is subject to constant periodic flooding by tidal waters which presents the chief problem to management. The restricted internal drainage, high salt content, and presence of sulfidic materials further restrict its use.

In its natural condition, the soil is covered with herbaceous, salt-tolerant plants typical of the high marsh. The dominant species are Spartina patens, salt meadow grass, and Juncus gerardii, black grass. Where installed, open drainage ditches have not materially improved the soil's potential for agricultural production. Salinity and flooding preclude the growth of forest trees.

All areas of this soil are in natural vegetation. Its best use is for wetland wildlife habitat development.

797 Typic Sulfaquents, organic materials less than 16 inches thick overlying sandy materials.

This soil of the high marsh lies at the extreme seaward margin of the coastal marshes on the gently shelving sands of the barrier beach. It is also in small areas on the western side of Great Bay and several streams flowing into it. The areas of this soil range from 2 to 10 acres in extent.

Included in the mapping are narrow areas of soils with organic materials 16 to 50 inches in thickness where stream channels cut across the marsh, and small areas of rock outcrop less than one-fourth acre in size.

Periodic flooding and high salinity are major problems to management of this soil. Associated problems are a high water table and the presence of sulfidic materials.

The natural vegetation comprises salt-tolerant herbaceous plants, dominantly Spartina patens, salt meadow grass; Juncus gerardii, black grass; and Salicornia virginica, perennial glasswort, on the coastal marsh. The periodic flooding and high salinity inhibit the growth of trees.

The size and configuration of the areas of this soil, in addition to the problems of salinity and tidal flooding, limit any farming operations except the harvesting of native salt hay. The thin surface organic horizons and the underlying sands do not present the problems to filling, when flooding is controlled, presented by the other soils. In fact, perhaps one-third of the original extent of this soil has been filled and is being used for various forms of community development. In its natural condition, however, its best use is to wetland wildlife habitat development.

997 Sulfihemists, surface soils with low salt, organic materials thicker than 50 inches, or 16 to 50 inches thick overlying sandy or silty materials.

This soil commonly occurs in small areas at the headwaters of streams feeding into the marshes and along the banks-in pockets and long narrow bands-of the larger tidal rivers flowing into the Great Bay complex. In size, these areas run from 1 acre to 10 acres.

Included in the mapping are small depressions on the surface of the marsh flooded by salt water at spring tides. These small pockets have high salt surface soils due to evaporation of trapped salt water and insufficient flushing by fresh water.

Slow internal drainage, a very high water table, presence of sulfidic materials, and periodic flooding are major problems in managing this soil. The long, narrow shape and small size of many areas of this soil are further restrictions to management.

On those areas of intertidal marsh Spartina alterniflora, salt water cordgrass, is the dominant vegetation. On the high marsh portion of this soil, in addition to Spartina patens, are found many plant species unable to withstand the higher salt concentrations of other tidal marsh soils. Typical of such plants are *Spartina pectinata*, fresh water cordgrass, and *Typha spp.*, the cattails.

The soil has little or no value for farming and will not support forest tree growth. It is well suited to wetland wildlife habitat development.

SOIL SURVEY INTERPRETATIONS

Soil survey interpretations provide information about engineering properties of soils, the suitability of soils as resource material, and major soil features affecting engineering uses of soils. The interpretations also provide information relative to the degree of soil limitations for town and country planning and recreational uses, and suitability for farm uses.

The purpose of soil survey interpretations is to provide users of soil maps with predictions of soil behavior. The interpretations are predictions of soil behavior under stated conditions.

Three degrees of soil limitations are given for town and country planning and recreational uses. They are defined as follows:

<u>Slight</u> -- rating given soils that have properties favorable for the intended use. The degree of limitation is minor and can be overcome easily. Considered to have the best potential.

<u>Moderate</u> -- rating given soils that have properties moderately favorable for the intended use. Limitations can be overcome or modified by special planning, design, or maintenance. Considered to have intermediate potential.

<u>Severe</u> -- rating given soils that have one or more properties unfavorable for the intended use. Generally requires major soil reclamation, special design, or intensive maintenance. Considered to have the poorest potential.

A rating of severe does not necessarily mean that a soil cannot be used for the intended use. However, it does mean that severe limitations exist that must be overcome. It commonly is more expensive to develop soils with a severe limitation than those with slight or moderate limitations.

<u>The interpretations will not eliminate the need for onsite sampling, testing, and a study of specific sites for design and construction of engineering works and other uses</u>. Soil survey interpretations are helpful in planning more detailed field investigations to determine the conditions of the soil at the precise site for the intended use. Soil classification, mapping, and interpretation ordinarily apply to the upper 4½ feet.

Soil properties do not function independently of each other. The influence of any one soil property depends upon the other soil properties present. The criteria for interpretations are based upon present knowledge and may change in the future with more experience and data.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES FOR ENGINEERING

Information presented in this table consists of estimates and does not represent actual test data. The estimates are based on engineering tests on selected benchmark soils and criteria set forth in engineering guides.

<u>Depth from Surface</u> -- This column gives the depth in inches from the surface for the major horizons or layers in the undisturbed soil.

<u>U.S.D.A. Texture</u> -- The U.S.D.A. texture is based on the relative amounts of sand, silt, and clay in a mass of soil giving rise to

soil textural classes such as loamy sand, sandy loam, and loam.

Unified Classification -- The unified soil classification system is based on identification of soils according to their texture and plasticity and their performance as engineering construction material (U.S. Department of Defense, 1968 Unified Soil Classification System for Roads, Airfields, Embankments, and Foundations. MIL-STD-619B, 30 pp., illus.). In this system soil material is grouped into 15 classes; 8 classes are for coarse grained material (GW, GP, GM, GC, SW, SP, SC, SM), 6 for fine grained material (ML, CL, PL, MH, CH, OH), and 1 for organic material (Pt). Soils on the borderline between two classes are designated by symbols for both classes; for example, SP-SM.

AASHO Classification -- The AASHO system is used to classify soils according to the properties that affect use in highway and maintenance construction. This system is based on gradation, liquid limit, and plasticity index of the soil. The seven basic groups range from A-1 (gravelly soil of high bearing capacity, the best soils for subgrades) to A-7 (clayey soils having low strength when wet, the poorest soil for subgrades). (American Association of State Highway Officials, 1961 Standard Specifications for Highway Materials and Methods of Sampling and Testing, Ed. 8, 2 v., illus.).

Percentage Less Than 3 Inches Passing Sieve No. -- The estimated percentages of material passing the number 4 (4.76 mm), 10 (2.0 mm), and the 200 (0.74 mm) is given for each major horizon. When there is very little gravel size material (No. 4 and 10 sieve) present, the percent passing the 200 sieve approximates the amount of silt and clay in the U.S.D.A. Soil Classification System. Values are rounded off to the nearest 5%.

Permeability -- Values listed represent the estimated rate of downward movement of water through undisturbed and uncompacted soil. It does not include lateral seepage or upward movement under artesian pressure. The estimates are based mainly on structure and porosity of the soil and on tests of undisturbed cores of similar soils. The permeability classes and the inches per hour for each class is listed below:

Permeability Class	Inches Per Hour
Slow	Less than 0.2
Moderately slow	0.2 - 0.6
Moderate	0.6 - 2.0
Moderately rapid	2.0 - 6.0
Rapid	More than 6.0

Soil Reaction (pH) -- Soil reaction or the intensity of soil acidity or alkalinity is expressed in pH values. A pH of 7.0 is neutral in reaction because it is neither acid nor alkaline. Lower values indicate acidity and higher values show alkalinity.

Shrink-Swell Potential -- Indicates the degree of volume change to be expected with a change in moisture content. It is estimated primarily on the basis of the amount and type of clay present. Four classes, very low, low, moderate, and high, are used to express shrink-swell. They are relative ratings and do not carry any quantitative values.

Depth to Bedrock (Ft.) -- Estimated depth to bedrock expressed in feet and given as a range to the nearest foot. These estimates are based on field observations.

Flood Hazard -- Tidal marsh areas that are subject to flooding by shallow water at high tide.

Potential Frost Action -- Estimated for the soil as it occurs in place. Frost action is the heaving caused by ice lenses forming in the soil and the subsequent loss of strength as a result of excess moisture during thawing periods. As a general rule, soils with more than 3 percent of its particles 0.02 mm and smaller, are frost susceptible. Three classes are used--Low, Moderate, and High.

Depth to Seasonal High Water Table (Ft.) -- Expressed as a range in feet to the nearest one-half foot based on observed characteristics of the soil.

Hydrologic Group -- The hydrologic grouping of soils is based on infiltration rates as they affect runoff. Tidal marsh soils fall into Group D and are described as follows:

Group D -- Soils having very slow infiltration rates when thoroughly wetted. They consist chiefly of (1) clay soils with a high swelling potential, (2) soils with a permanent high water table (very poorly drained), (3) soils with a clay pan or a clay layer at or near the ground surface, and (4) shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission.

SUITABILITY AND MAJOR FEATURES AFFECTING SOIL AS A RESOURCE MATERIAL

Topsoil -- Topsoil, as used here, refers to soil material, preferably rich in organic matter, that is used to topdress roadbanks, lawns, gardens, and the like. Generally, only the surface layer is rated. Soils are rated as good, fair, poor, or unsuited.

Sand -- Suitability of the soil as a source of sand is given for material to a depth of about 4 feet. Ratings are based on the probability that the soil generally contains sizable quantities of sand. Quality and ease of excavation were not considered in the ratings. General rating terms are <u>good</u>, <u>fair</u>, <u>poor</u>, and <u>unsuited</u>.

<u>Gravel</u> -- Suitability of the soil as a source of gravel (2 mm to 3 inches in size) is given for material to a depth of about 4 feet. Ratings are based on the probability that certain soils contain suitable deposits of gravel. Quality and quantity of gravel deposits and ease of excavation were not considered in the ratings. General rating terms are <u>good</u>, <u>fair</u>, <u>poor</u>, and <u>unsuited</u>.

<u>Roadfill</u> -- Suitability ratings for roadfill are based on the performance of the soil material when excavated and used as borrow for highway subgrade. Soils are rated as <u>good</u>, <u>fair</u>, <u>poor</u>, or <u>unsuited</u>.

<u>Daily Cover for Landfill</u> -- Suitability of a soil for use as daily cover for landfill is based on properties that reflect workability, ease of digging, moving, and spreading over the refuse during both wet and dry periods. General rating terms are <u>good</u>, <u>fair</u>, <u>poor</u>, and <u>unsuited</u>.

MAJOR SOIL FEATURES AFFECTING SPECIFIC ENGINEERING USES

<u>Highway Location</u> -- Highway location pertains to superhighways similar to those of the interstate system and not to local roads and streets.

<u>Pond Reservoir Areas</u> -- Factors considered in selecting soils for this use are those features and qualities that affect the suitability of undisturbed soils for water impoundment.

Pond Embankments -- Cited for pond embankments are properties and major behavior qualities that affect the performance of soils if used in constructing earthfills intended for holding back water.

Drainage -- Soil features and qualities considered are those that affect the installation and performance of surface and subsurface drainage systems. They are permeability, texture, structure, depth to water table, depth to bedrock, stability of ditch banks, tidal flood hazard, and potential sulfur acidity.

DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING TOWN AND COUNTRY PLANNING

Septic Tank Absorption Field -- A septic tank absorption field is a soil absorption system for sewage disposal. It consists of a subsurface tile system laid in such a way that effluent from the septic tank is distributed with reasonable uniformity into the natural soil. The successful operation of a septic tank system depends on the absorptive quality of the soil and the level of the water table during wet seasons. However, design, construction, and maintenance are just as critical as is the kind of soil being used for disposal.

Sewage Lagoon -- A sewage lagoon is a shallow pond used to hold sewage for the time required for bacterial decomposition, the process of which is mainly biochemical. Sewage lagoons require consideration of the soil as a vessel for the impounded area and as soil material for the enclosing embankment.

Dwellings (with basements) -- Ratings are for undisturbed soils on which single-family dwellings or other structures with similar foundation requirements can be built. Buildings are three stories or less and have basements that extend to a depth of at least 5 feet below ground level.

Dwellings (without basements) -- Dwellings without basements include cottages, summer homes, lodges, and service buildings. It is assumed that construction will be on a slab or on concrete, wood or steel columns. Ratings are for undisturbed soils on which single-family dwellings (three stories or less) or other structures with similar foundation requirements are built.

Lawns and Landscaping -- Ratings for lawns and landscaping are based on soil properties that affect the establishment and maintenance of lawns and shrubs. It is assumed that the lawns will be subject to moderate foot traffic and fill or topsoil is not brought in.

Local Roads, Streets and Parking Lots -- Ratings apply to the use of soils for construction and maintenance of improved local roads, streets, and parking lots that have all-weather surfacing--commonly of asphalt or concrete--and that are expected to carry automobile traffic all year.

Shallow Excavations (6 feet or less) -- These excavations require excavating or trenching to a depth of 6 feet. Limitation ratings for shallow excavations alone are insufficient for such uses as dwellings with basements and underground utility lines. Additional soil features must be considered in evaluating soils for those uses.

DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING RECREATION DEVELOPMENT

Camp Areas (Tent and Camp Trailers) -- Ratings apply to soils to be used for tent and camp trailers and the accompanying activities of outdoor living.

Picnic Areas (Park Type) -- Ratings apply to soils considered for use as park-type picnic areas.

Playgrounds (Athletic Fields) -- Ratings apply to soils to be used intensively as playing fields or courts for baseball, football, volleyball, soccer, or other similar organized games in which soils are subject to heavy foot traffic. Soil suitability for growing and maintaining vegetation is not part of the ratings.

Paths and Trails (Hiking and Bridle) -- Ratings apply to soils to be used for local and cross-country footpaths and trails and for bridle paths. It is assumed that these areas will be used as they occur in nature and that little or no soil will be moved.

SUITABILITY AND MAJOR SOIL FEATURES AFFECTING FARM USE

The purpose of this interpretation is to make broad generalizations about the suitability of soils for farm use. This information is not intended for use in planning activities with commercial farm operations. Suitability ratings are based on soil potentials, limitations in use and management problems.

Four suitability ratings are used and defined as follows:

Good -- The soil can be expected to produce sustained satisfactory yields of the crop indicated, without extensive conservation treatment.

Fair -- The soil can be expected to grow any locally adapted crop, but yields will be below a soil rated "Good" for that crop or simple conservation measures may be necessary to grow the crop.

Poor -- Yields of locally adapted crops will normally be substantially lower than those soils rated "Good" for that crop or intensive conservation measures are necessary to sustain production.

Unsuitable -- The soil is incapable of producing economical yields of locally adapted crops. Conservation measures are not usually feasible or practicable.

Truck Crops -- Truck crops are commonly grown vegetable crops such as carrots, beans, peas, and squash.

Field Crops -- Field crops are cultivated row crops such as corn for silage, corn for grain, and potatoes.

Hay and Pasture Crops -- The hay and pasture crops used in this interpretation are those grasses commonly recommended by local and agricultural leaders such as timothy, reed canary grass, orchard grass, and smooth brome grass.

Some Important Considerations in an Excavation Operation

The potential for acid formation with the resultant significant drop in pH values is an important factor to consider where an excavation operation of tidal marsh sediments is under consideration. These sediments excavated from a trench and then stockpiled and allowed to air dry will produce acid. Some effects of such an operation are as follows:

1. Sufficient acid will be produced to corrode concrete or metal structures unless adequate precautions are taken.

2. The acid would be toxic to vegetative plantings that may be planned for the area.

3. The acid produced would be a hazard to the ecology of adjoining areas, especially nearby estuarine or tidal marshes.

4. Subsidence resulting from an overburdening of the tidal marsh soils is a distinct hazard due to the high organic matter content of these soils.

Some Important Considerations Where Drainage is Planned

The potential for acid formation also needs to be considered in any operation involving drainage of an area of the tidal marsh. A drainage operation involving diking and pumping will need to consider the four effects outlined above as well as the following:

1. Neutralization of the potential acid with limestone would be impractical if not impossible, due to the large amounts and depth of application involved.

SOIL SURVEY INTERPRETATIONS

SOIL: Typic Sulfihemists, organic materials thicker than 50 inches.
MAP SYMBOL(S): 397
BRIEF SOIL DESCRIPTION:

STATE: N. H.
DATE: 4/74
MLRA(S): 144

These soils consist of very poorly drained organic materials more than 50 inches thick. They occupy tidal marshes that are subject to flooding by shallow water at high tide. An important property of these soils is the presence of sulfidic materials.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES FOR ENGINEERING

Depth From Surface (Inches)	Classification			Percentage Less Than 3 Inches Passing Sieve No. ___			Perme-ability (in/hr)		Soil Reaction water (pH)	Shrink-Swell Potential
	USDA Texture	Unified	AASHO	4	10	200				
0 - 63	--	Pt	--	--	--	--	--		6.0-7.8	--

Depth to Bedrock (Ft): 4.5 - 10+
Flood Hazard: Tidal flooding
Potential Frost Action: High
Depth to Seasonal High Water Table (Ft): 0
Hydrologic Group: D

SUITABILITY AND MAJOR FEATURES AFFECTING SOIL AS A RESOURCE MATERIAL

Topsoil	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Sand	Unsuited: High in organic matter, tidal flooding
Gravel	Unsuited: High in organic matter, tidal flooding
Roadfill	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Daily Cover For Landfill	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding

MAJOR SOIL FEATURES AFFECTING SPECIFIED ENGINEERING USES

Highway Location	High in organic matter, poor stability, tidal flooding
Pond Reservoir Areas	High in organic matter, tidal flooding
Pond Embankments	High in organic matter, tidal flooding
Drainage	High in organic matter, tidal flooding

DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING TOWN AND COUNTRY PLANNING

Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Septic Tank Absorption Field	All	Severe	Tidal flooding, high in organic matter
Sewage Lagoon	All	Severe	Tidal flooding, high in organic matter
Dwellings (With Basements)	All	Severe	Tidal flooding, high in organic matter, poor stability
Dwellings (Without Basements)	All	Severe	Tidal flooding, high in organic matter, poor stability
Lawns and Landscaping	All	Severe	Tidal flooding, high in organic matter
Local Roads, Streets and Parking Lots	All	Severe	Tidal flooding, high in organic matter, poor stability
Shallow Excavations (6 feet or less)	All	Severe	Borrow material has acid sulfate production potential, Tidal flooding, high in organic matter

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DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING RECREATION DEVELOPMENT			
Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Camp Areas (Tent and Camp Trailers)	All	Severe	Tidal flooding, high in organic matter
Picnic Areas (Park-Type)	All	Severe	Tidal flooding, high in organic matter
Playgrounds (Athletic Fields)	All	Severe	Tidal flooding, high in organic matter
Paths and Trails (Hiking and Bridle)	All	Severe	Tidal flooding, high in organic matter

SUITABILITY AND MAJOR SOIL FEATURES AFFECTING FARM USE			
Use	Slope	Suitablity	Major Soil Feature(s) Affecting Use
Truck Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Field Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Hay and Pasture Crops	All	Unsuited	Tidal flooding, potential acid sulfate production (harvesting of saltgrass hay not considered)

SOIL SURVEY INTERPRETATIONS

SOIL: Terric Sulfihemists over sand, organic materials 16 to 50 inches thick overlying sandy materials

STATE: N. H.

MAP SYMBOL(S): 497

DATE: 4/74

BRIEF SOIL DESCRIPTION:

MLRA(S): 144

These soils consist of very poorly drained organic materials 16 to 50 inches thick overlying sand or loamy sand. They occupy tidal marshes that are subject to flooding by shallow water at high tide. An important property of these soils is the presence of sulfidic materials.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES FOR ENGINEERING

Depth From Surface (Inches)	Classification			Percentage Less Than 3 Inches Passing Sieve No.			Permeability (in/hr)		Soil Reaction water (pH)	Shrink-Swell Potential
	USDA Texture	Unified	AASHO	4	10	200				
0 - 35	--	Pt	--	--	--	--	--		6.0-7.4	--
35 - 51	sand, loamy sand,	SM SP-SM	A-2 A-3	100	95-100	5-20	6.0		6.5-7.8	Very low

Depth to Bedrock (Ft): 4.5 - 10+

Depth to Seasonal High Water Table (Ft): 0

Flood Hazard: Tidal flooding

Potential Frost Action: High

Hydrologic Group: D

SUITABILITY AND MAJOR FEATURES AFFECTING SOIL AS A RESOURCE MATERIAL

Topsoil	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Sand	Unsuited: Potential acid sulfate production, tidal flooding
Gravel	Unsuited: Excess fines, tidal flooding
Roadfill	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Daily Cover For Landfill	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding

MAJOR SOIL FEATURES AFFECTING SPECIFIED ENGINEERING USES

Highway Location	Tidal flooding, poor stability
Pond Reservoir Areas	High in organic matter, tidal flooding
Pond Embankments	High in organic matter
Drainage	High in organic matter, tidal flooding

DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING TOWN AND COUNTRY PLANNING

Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Septic Tank Absorption Field	All	Severe	Tidal flooding, high in organic matter
Sewage Lagoon	All	Severe	Tidal flooding, high in organic matter
Dwellings (With Basements)	All	Severe	Tidal flooding, high in organic matter, poor stability
Dwellings (Without Basements)	All	Severe	Tidal flooding, high in organic matter, poor stability
Lawns and Landscaping	All	Severe	Tidal flooding, high in organic matter
Local Roads, Streets and Parking Lots	All	Severe	Tidal flooding, high in organic matter, poor stability
Shallow Excavations (6 feet or less)	All	Severe	Borrow material has acid sulfate production potential Tidal flooding, high in organic matter

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DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING RECREATION DEVELOPMENT			
Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Camp Areas (Tent and Camp Trailers)	All	Severe	Tidal flooding, high in organic matter
Picnic Areas (Park-Type)	All	Severe	Tidal flooding, high in organic matter
Playgrounds (Athletic Fields)	All	Severe	Tidal flooding, high in organic matter
Paths and Trails (Hiking and Bridle)	All	Severe	Tidal flooding, high in organic matter

SUITABILITY AND MAJOR SOIL FEATURES AFFECTING FARM USE			
Use	Slope	Suitablity	Major Soil Feature(s) Affecting Use
Truck Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Field Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Hay and Pasture Crops	All	Unsuited	Tidal flooding, potential acid sulfate production (harvesting of saltgrass hay not considered)

SOIL SURVEY INTERPRETATIONS

SOIL: Terric Sulfihemists over silt, organic materials 16 to 50 inches thick overlying silty materials
STATE: N. H.
MAP SYMBOL(S): 597
DATE: 4/74
MLRA(S): 144

BRIEF SOIL DESCRIPTION:
These soils consist of very poorly drained organic materials 16 to 50 inches thick overlying silt loam, silty clay loam, or silty clay. They occupy tidal marshes that are subject to flooding by shallow water at high tide. An important property of these soils is the presence of sulfidic materials.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES FOR ENGINEERING

Depth From Surface (Inches)	Classification			Percentage Less Than 3 Inches Passing Sieve No.			Permeability (in/hr)	Available Water Capacity (in/in)	Soil Reaction (pH)	Shrink-Swell Potential
	USDA Texture	Unified	AASHO	4	10	200				
0 - 38	---	Pt	--	--	--	--	--		6.0-7.4	--
38 - 51	silt loam, silty clay loam, silty clay	ML CL	A-4 A-6 A-7	100	100	75-95	0.2-0.6		6.5-7.8	Low

Depth to Bedrock (Ft): 4.5 - 10+
Depth to Seasonal High Water Table (Ft): 0
Flood Hazard: Tidal flooding
Potential Frost Action: High
Hydrologic Group: D

SUITABILITY AND MAJOR FEATURES AFFECTING SOIL AS A RESOURCE MATERIAL

Topsoil	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Sand	Unsuited: High in organic matter, excess fines
Gravel	Unsuited: High in organic matter, excess fines
Roadfill	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Daily Cover For Landfill	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding

MAJOR SOIL FEATURES AFFECTING SPECIFIED ENGINEERING USES

Highway Location	Tidal flooding, poor stability
Pond Reservoir Areas	High in organic matter, tidal flooding
Pond Embankments	High in organic matter
Drainage	High in organic matter, tidal flooding

DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING TOWN AND COUNTRY PLANNING

Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Septic Tank Absorption Field	All	Severe	Tidal flooding, high in organic matter
Sewage Lagoon	All	Severe	Tidal flooding, high in organic matter
Dwellings (With Basements)	All	Severe	Tidal flooding, high in organic matter, poor stability
Dwellings (Without Basements)	All	Severe	Tidal flooding, high in organic matter, poor stability
Lawns and Landscaping	All	Severe	Tidal flooding, high in organic matter
Local Roads, Streets and Parking Lots	All	Severe	Tidal flooding, high in organic matter, poor stability
Shallow Excavations (6 feet or less)	All	Severe	Borrow material has acid sulfate production potential Tidal flooding, high in organic matter

DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING RECREATION DEVELOPMENT			
Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Camp Areas (Tent and Camp Trailers)	All	Severe	Tidal flooding, high in organic matter
Picnic Areas (Park-Type)	All	Severe	Tidal flooding, high in organic matter
Playgrounds (Athletic Fields)	All	Severe	Tidal flooding, high in organic matter
Paths and Trails (Hiking and Bridle)	All	Severe	Tidal flooding, high in organic matter

SUITABILITY AND MAJOR SOIL FEATURES AFFECTING FARM USE			
Use	Slope	Suitablity	Major Soil Feature(s) Affecting Use
Truck Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Field Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Hay and Pasture Crops	All	Unsuited	Tidal flooding, potential acid sulfate production (harvesting of saltgrass hay not considered)

SOIL SURVEY INTERPRETATIONS

SOIL: Lithic Sulfihemists, organic materials 16 to 50 inches thick overlying bedrock.
STATE: N. H.
MAP SYMBOL(S): 697
DATE: 4/74
MLRA(S): 144

BRIEF SOIL DESCRIPTION:
These soils consist of very poorly drained organic materials 16 to 50 inches thick overlying bedrock. They occupy tidal marshes that are subject to flooding by shallow water at high tide. An important property of these soils is the presence of sulfidic materials.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES FOR ENGINEERING

Depth From Surface (Inches)	Classification			Percentage Less Than 3 Inches Passing Sieve No. ___			Perme-ability (in/hr)		Soil Reaction water (pH)	Shrink-Swell Potential
	USDA Texture	Unified	AASHO	4	10	200				
0 - 47	--	Pt	--	--	--	--	--		6.0-7.4	--
47+	Bedrock									

Depth to Bedrock (Ft): 1.5 - 4
Depth to Seasonal High Water Table (Ft): 0
Flood Hazard: Tidal flooding
Potential Frost Action: High
Hydrologic Group: D

SUITABILITY AND MAJOR FEATURES AFFECTING SOIL AS A RESOURCE MATERIAL

Topsoil	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Sand	Unsuited: High in organic matter, tidal flooding
Gravel	Unsuited: High in organic matter, tidal flooding
Roadfill	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Daily Cover For Landfill	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding

MAJOR SOIL FEATURES AFFECTING SPECIFIED ENGINEERING USES

Highway Location	Tidal flooding, poor stability of organic materials
Pond Reservoir Areas	Tidal flooding, presence of bedrock
Pond Embankments	High in organic matter, presence of bedrock
Drainage	High in organic matter, presence of bedrock, tidal flooding

DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING TOWN AND COUNTRY PLANNING

Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Septic Tank Absorption Field	All	Severe	Tidal flooding, presence of bedrock, high water table
Sewage Lagoon	All	Severe	Tidal flooding, presence of bedrock, high water table
Dwellings (With Basements)	All	Severe	Tidal flooding, presence of bedrock, high water table
Dwellings (Without Basements)	All	Severe	Tidal flooding, high water table
Lawns and Landscaping	All	Severe	Tidal flooding, high water table
Local Roads, Streets and Parking Lots	All	Severe	Tidal flooding, high water table
Shallow Excavations (6 feet or less)	All	Severe	Organic borrow material has acid sulfate production potential Tidal flooding, presence of bedrock, high water table

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DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING RECREATION DEVELOPMENT			
Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Camp Areas (Tent and Camp Trailers)	All	Severe	Tidal flooding, high water table
Picnic Areas (Park-Type)	All	Severe	Tidal flooding, high water table
Playgrounds (Athletic Fields)	All	Severe	Tidal flooding, high water table
Paths and Trails (Hiking and Bridle)	All	Severe	Tidal flooding, high water table

SUITABILITY AND MAJOR SOIL FEATURES AFFECTING FARM USE			
Use	Slope	Suitablity	Major Soil Feature(s) Affecting Use
Truck Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Field Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Hay and Pasture Crops	All	Unsuited	Tidal flooding, potential acid sulfate production (harvesting of saltgrass hay not considered)

SOIL SURVEY INTERPRETATIONS

SOIL: Typic Sulfaquents, organic materials less than 16 inches thick overlying sandy materials.
MAP SYMBOL(S): 797
BRIEF SOIL DESCRIPTION:

STATE: N. H.
DATE: 4/74
MLRA(S): 144

These soils consist of very poorly drained organic materials less than 16 inches thick overlying sands or loamy sands. They occupy tidal marshes that are subject to flooding by shallow water at high tide. An important property of these soils is the presence of sulfides.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES FOR ENGINEERING

Depth From Surface (Inches)	Classification			Percentage Less Than 3 Inches Passing Sieve No. ___			Permeability (in/hr)		Soil Reaction water (pH)	Shrink-Swell Potential
	USDA Texture	Unified	AASHO	4	10	200				
0 - 9	--	Pt	--	--	--	--	--		6.0-7.4	--
9 - 51	sand, loamy sand,	SM SP-SM	A-2 A-3	100	95-100	5-20	6.0		6.5-7.8	Very low

Depth to Bedrock (Ft): 4.5 - 10+
Flood Hazard: Tidal flooding
Potential Frost Action: High
Depth to Seasonal High Water Table (Ft): 0
Hydrologic Group: D

SUITABILITY AND MAJOR FEATURES AFFECTING SOIL AS A RESOURCE MATERIAL

Topsoil	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Sand	Unsuited: Potential acid sulfate production, tidal flooding
Gravel	Unsuited: Excess fines, tidal flooding
Roadfill	Unsuited: Potential acid sulfate production, tidal flooding
Daily Cover For Landfill	Unsuited: Potential acid sulfate production, tidal flooding

MAJOR SOIL FEATURES AFFECTING SPECIFIED ENGINEERING USES

Highway Location	Tidal flooding, high water table
Pond Reservoir Areas	Tidal flooding
Pond Embankments	Rapid permeability
Drainage	Tidal flooding, high water table

DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING TOWN AND COUNTRY PLANNING

Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Septic Tank Absorption Field	All	Severe	Tidal flooding, high water table
Sewage Lagoon	All	Severe	Tidal flooding, high water table
Dwellings (With Basements)	All	Severe	Tidal flooding, high water table
Dwellings (Without Basements)	All	Severe	Tidal flooding, high water table
Lawns and Landscaping	All	Severe	Tidal flooding, high water table
Local Roads, Streets and Parking Lots	All	Severe	Tidal flooding, high water table
Shallow Excavations (6 feet or less)	All	Severe	Borrow material has acid sulfate production potential Tidal flooding, high water table

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DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING RECREATION DEVELOPMENT			
Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Camp Areas (Tent and Camp Trailers)	All	Severe	Tidal flooding, high water table
Picnic Areas (Park-Type)	All	Severe	Tidal flooding, high water table
Playgrounds (Athletic Fields)	All	Severe	Tidal flooding, high water table
Paths and Trails (Hiking and Bridle)	All	Severe	Tidal flooding, high water table

SUITABILITY AND MAJOR SOIL FEATURES AFFECTING FARM USE			
Use	Slope	Suitablity	Major Soil Feature(s) Affecting Use
Truck Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Field Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Hay and Pasture Crops	All	Unsuited	Tidal flooding, potential acid sulfate production (harvesting of saltgrass hay not considered)

SOIL SURVEY INTERPRETATIONS

SOIL: Sulfihemists, surface soil materials with low salt, organic materials thicker than 50 inches, or 16 to 50 inches thick overlying sandy or silty materials.
MAP SYMBOL(S): 997
STATE: N. H.
DATE: 4/74
MLRA(S): 144

BRIEF SOIL DESCRIPTION:
These soils consist of very poorly drained organic materials thicker than 50 inches or organic materials 16 to 50 inches thick overlying sand or silt materials. They occupy estuaries and tidal marshes that commonly are subject to the influence of fresh waters from adjoining uplands. Total salt concentrations in surface soil materials are lower than other tidal marsh soils. An important property of these soils is the presence of sulfidic materials.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES FOR ENGINEERING

Depth From Surface (Inches)	Classification			Percentage Less Than 3 Inches Passing Sieve No. ___			Perme-ability (in/hr)		Soil Reaction water (pH)	Shrink-Swell Potential
	USDA Texture	Unified	AASHO	4	10	200				
0-65	----------------	----------	-Variable	---------	---------	---------	---------		6.0-7.8	Variable

Depth to Bedrock (Ft): 4.5 - 10+
Flood Hazard: Tidal Flooding
Potential Frost Action: High
Depth to Seasonal High Water Table (Ft): 0
Hydrologic Group: D

SUITABILITY AND MAJOR FEATURES AFFECTING SOIL AS A RESOURCE MATERIAL

Topsoil	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Sand	Unsuited: High in organic matter, tidal flooding
Gravel	Unsuited: High in organic matter, tidal flooding
Roadfill	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding
Daily Cover For Landfill	Unsuited: Potential acid sulfate production, high in organic matter, tidal flooding

MAJOR SOIL FEATURES AFFECTING SPECIFIED ENGINEERING USES

Highway Location	Tidal flooding, poor stability
Pond Reservoir Areas	High in organic matter, tidal flooding
Pond Embankments	High in organic matter
Drainage	High in organic matter, tidal flooding

DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING TOWN AND COUNTRY PLANNING

Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Septic Tank Absorption Field	All	Severe	Tidal flooding, high in organic matter
Sewage Lagoon	All	Severe	Tidal flooding, high in organic matter
Dwellings (With Basements)	All	Severe	Tidal flooding, high in organic matter, poor stability
Dwellings (Without Basements)	All	Severe	Tidal flooding, high in organic matter, poor stability
Lawns and Landscaping	All	Severe	Tidal flooding, high in organic matter
Local Roads, Streets and Parking Lots	All	Severe	Tidal flooding, high in organic matter, poor stability
Shallow Excavations (6 feet or less)	All	Severe	Borrow material has acid sulfate production potential, Tidal flooding, high in organic matter

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DEGREE OF SOIL LIMITATION AND MAJOR SOIL FEATURES AFFECTING RECREATION DEVELOPMENT			
Use	Slope	Degree of Limitation	Major Soil Feature(s) Affecting Use
Camp Areas (Tent and Camp Trailers)	All	Severe	Tidal flooding, high water table
Picnic Areas (Park-Type)	All	Severe	Tidal flooding, high water table
Playgrounds (Athletic Fields)	All	Severe	Tidal flooding, high water table
Paths and Trails (Hiking and Bridle)	All	Severe	Tidal flooding, high water table

SUITABILITY AND MAJOR SOIL FEATURES AFFECTING FARM USE			
Use	Slope	Suitablity	Major Soil Feature(s) Affecting Use
Truck Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Field Crops	All	Unsuited	Tidal flooding, potential acid sulfate production
Hay and Pasture Crops	All	Unsuited	Tidal flooding, potential acid sulfate production (harvesting of saltgrass hay not considered)

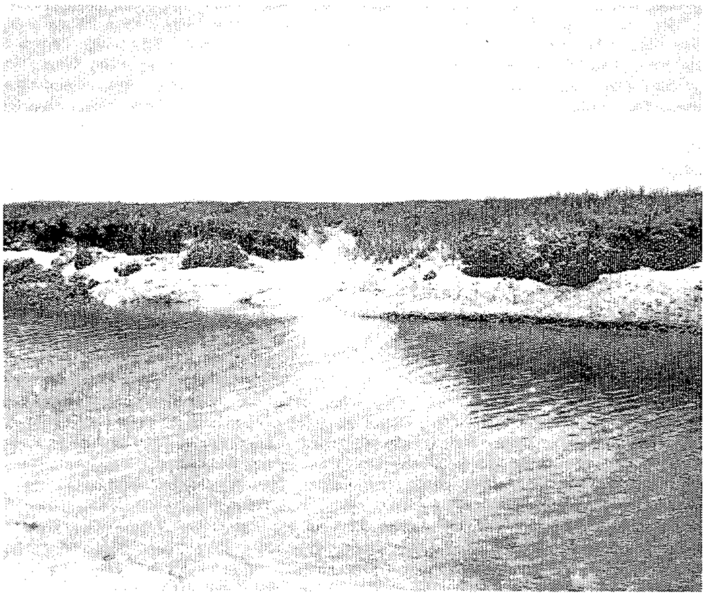

Fig. 3 Peat deposit overlying sands along bank of major tidal channel.

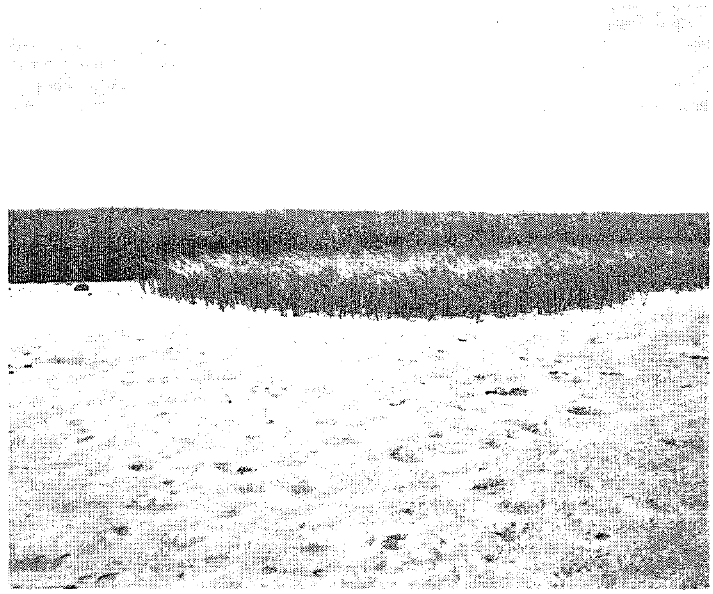

Fig. 5 Clonal spread of Spartina alterniflora onto exposed mud flat with scattered seedlings.

Fig. 6 Bank erosion facing Taylor River.

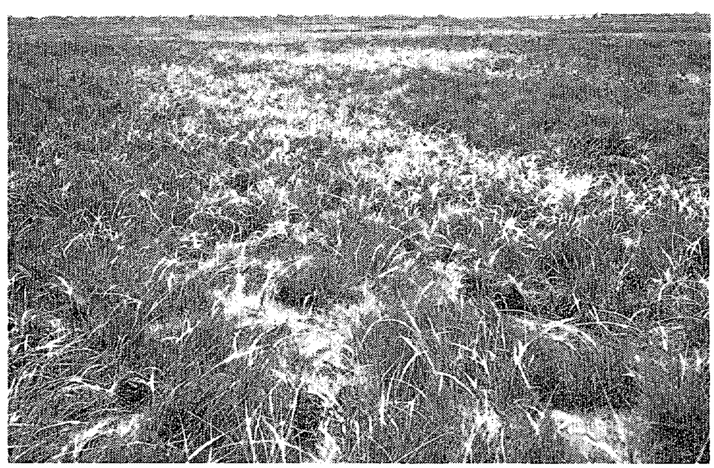

Fig. 7 Spartina alterniflora – Spartina patens association (S. alterniflora has broader leaves).

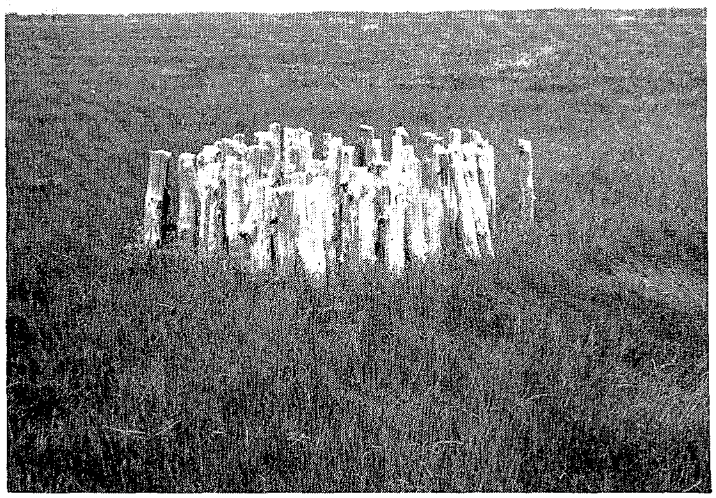

Fig. 8 Staddle for curing salt marsh hay.

Fig. 9A Forb panne association (Limonium, Plantago and Triglochin).

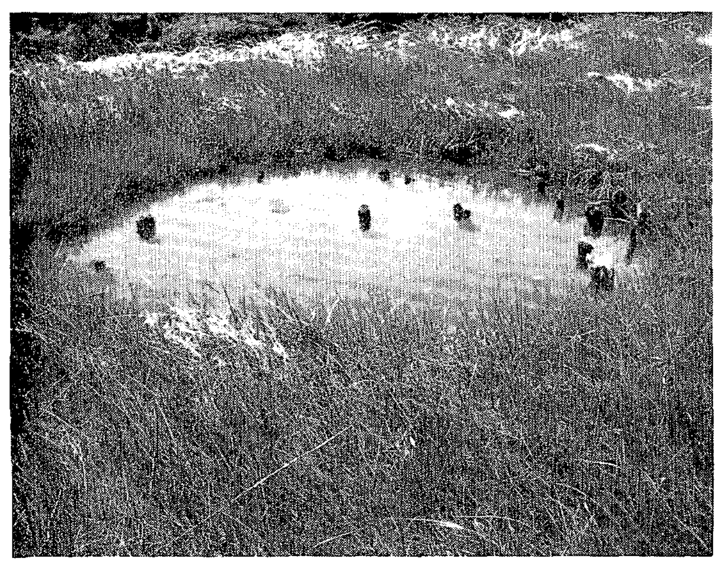

Fig. 9B Ruppia pool formed at site of old staddle.

Fig. 10 Levees along channel with Spartina patens growing on levees and S. alterniflora, dwarf form, in depressions behind levees.

Fig. 11 Close-up of dwarf form Spartina alterniflora.

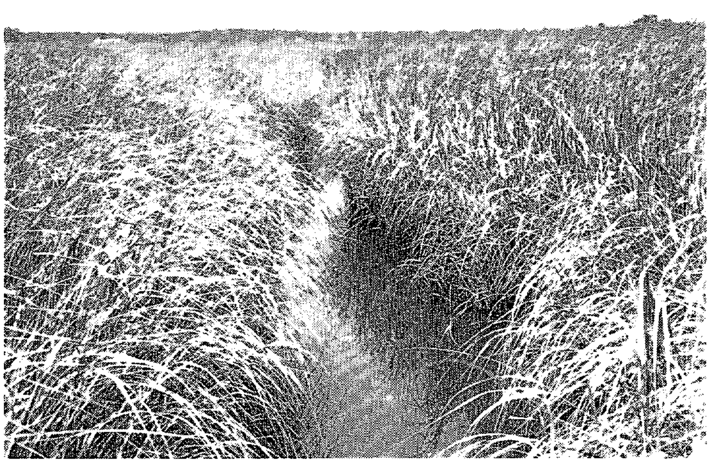

Fig. 12 Luxuriant growth of Spartina alterniflora along stream channel.

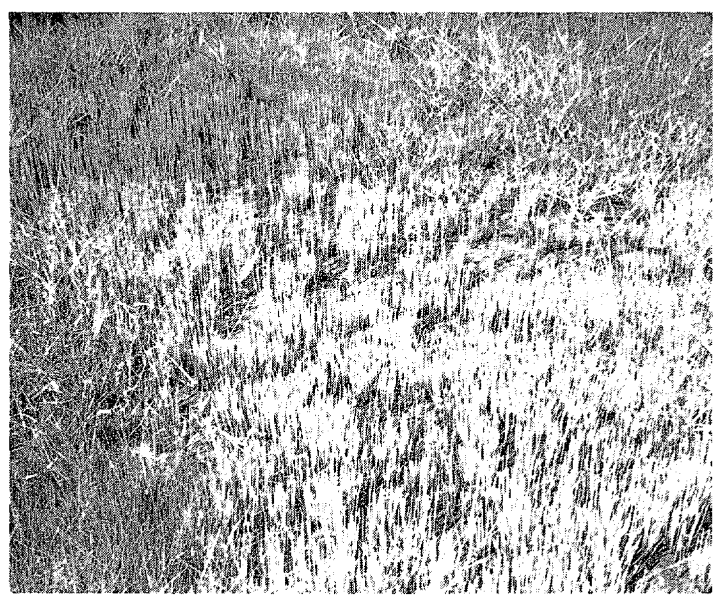

Fig. 13 Salicornia europaea growing on highly saline panne.

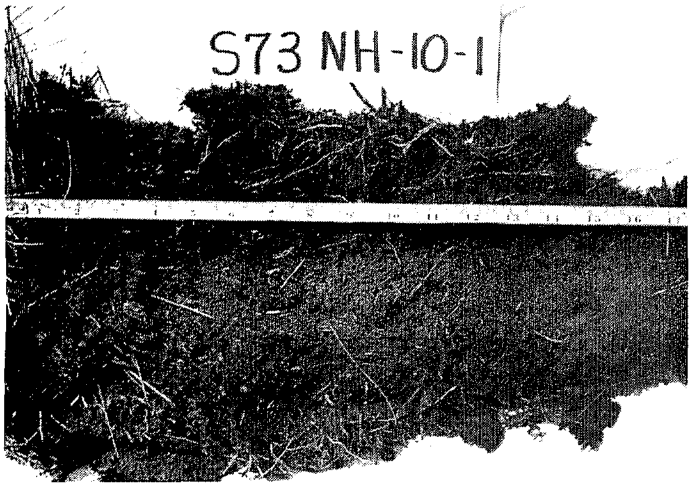

Fig. 14 Fibric soil material of surface tier. Fiber content (unrubbed) is about 4/5 of volume.

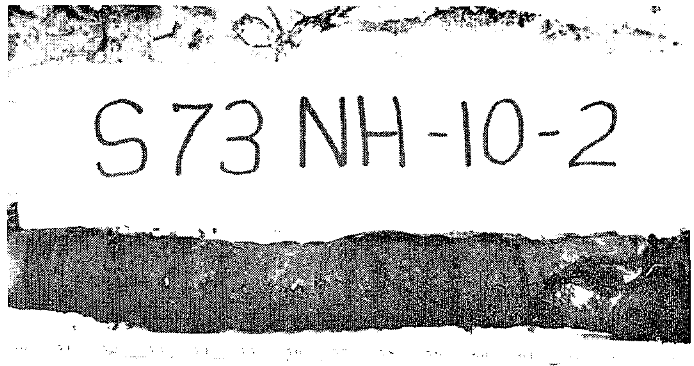

Fig. 15 Sapric soil material at 127 cm to 165 cm. Sampled with McCauley peat sampler. Fiber content (rubbed) is about 1/10 of volume.

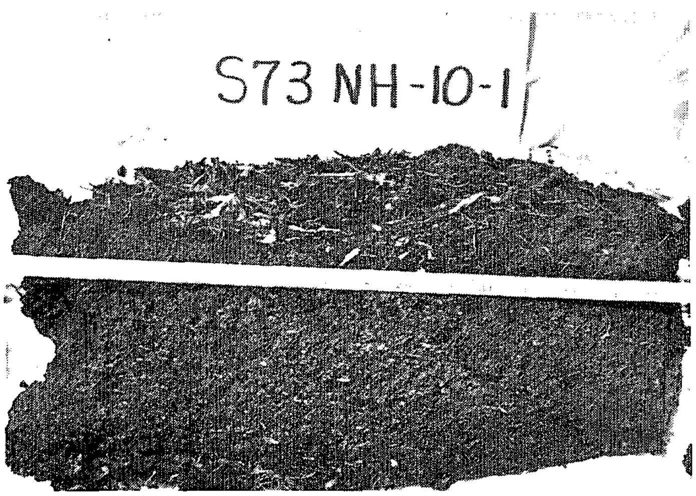

Fig. 16 Hemic soil material of subsurface tier. Fiber content (unrubbed) is about 2/3 of volume.

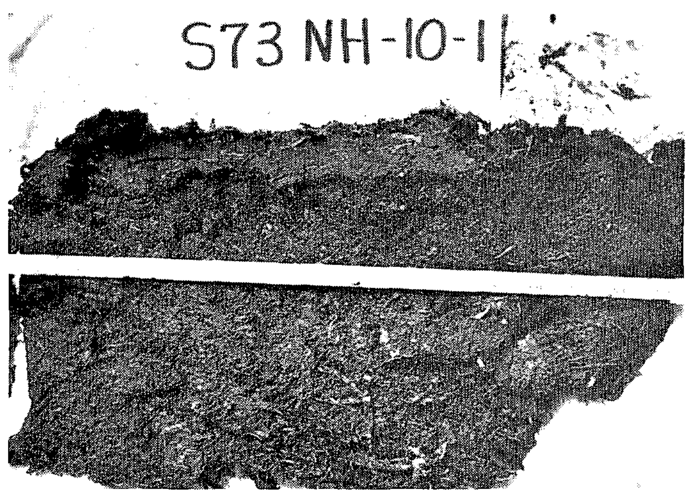

Fig. 17 Hemic soil material of bottom tier. Fiber content (unrubbed) is about 1/2 of volume.

Fig. 18 Profile of Terric Sulfihemists over silt. Note fibrous mat of surface layer.

Fig. 19 Preparing description of a tidal marsh soil.

CLASSIFICATION OF TIDAL MARSH SOILS

Perhaps the most important property of New Hampshire tidal marsh soils is the presence of sulfidic materials. These materials accumulate in both the organic and mineral soil materials under permanently saturated conditions. If the soils are drained, the sulfides oxidize and form sulfuric acid. These soils are commonly referred to as potential acid sulfate soils or 'cat clays'. The amount of acid produced in these soils is related to the total sulfur content and to the neutralizing effects of residual calcium carbonate.

The principal processes that lead to the formation of acid sulfate soils can be summarized as follows (Beers 1962):

1. In marine and brackish water sediments sulfur may be bound and accumulate under certain conditions in the form of iron sulfides and elementary sulfur as a result of the reduction of sulfates. The latter are chiefly derived from sea water.

2. When an area of this kind is drained the soil is aerated and the iron sulfides are consequently oxidized, sulfuric acid being formed together with Fe and Al sulfates which have a highly acid reaction.

3. a. When sufficient calcium carbonate is available the sulfuric acid released is neutralized to gypsum ($Ca\ So_4 .\ 2H_2O$); the absorbed Na and Mg are moreover largely replaced by Ca and the soil remains in good condition. Hence in this case, the presence of Fe sulfides has a favorable effect.

   b. If the amount of bases present is small compared to the sulfate present, there is extensive acidification of the soil, often resulting in a pH lower than 4, usually in the region of 3 and in extreme cases even lower than 2. The ultimate pH depends on the sulfur/base ratio.

A simple method used in the identification of potential acid sulfate soils involves the treatment of a soil sample with concentrated hydrogen peroxide and measuring the drop in pH. Table 5 provides soil pH data for selected tidal marsh soils.

Three additional properties are useful in the classification of New Hampshire tidal marsh soils. These include:

1. Kinds and thickness of organic soil materials.
2. Texture of underlying mineral soil materials.
3. Total salts of surface soil materials.

Three kinds of organic soil materials are identified according to the degree of decomposition of the original plant materials (Soil Survey Staff 1973). Fibric soil materials are the least decomposed. They contain large amounts of fibers that are well preserved. Fibric soil materials commonly occur in the surface tier (top 12 inches) of New Hampshire tidal marsh soils (Fig. 14) and less frequently in the subsurface tier (12 to 36 inch depths). Soil descriptions with the designations of Oi1, Oi2, etc., are used to identify fibric soil materials.

Sapric soil materials are the most highly decomposed. They normally have the smallest amount of plant fiber (Fig. 15). Sapric soil materials can occur in the surface tier, subsurface tier, or in the bottom tier (36 to 51 inch depths). Soil descriptions with the designations of Oa1, Oa2, etc., are used to identify sapric soil materials.

Hemic soil materials are intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric materials. Hemic soil materials commonly occur in the subsurface and bottom tiers (Fig. 16 and 17). Soil descriptions with the designations of Oe1, Oe2, etc., are used to identify hemic soil materials.

One classification unit is used for organic soil materials more than 50 inches in thickness and with high total salt concentrations.

The texture of underlying mineral soil materials is quite variable for New Hampshire tidal marsh soils. Common textures include sand and silt with less extensive areas underlain by marine clay. Separate classification units are used for soil materials consisting of 16 to 50 inches of organic materials overlying either sand or silt materials. Another classification unit is used for soil materials consisting of less than 16 inches of organic material overlying sand.

New Hampshire tidal marsh vegetation can be used as an indicator to differentiate surface soil materials with high total salt concentrations (more than 10,000 ppm) from lower total salt concentrations (less than 10,000 ppm). Tall reeds and sedges commonly occupy these lower salinity areas of the estuaries and tidal marshes that are subject to the influence of fresh waters from the adjoining uplands. The lower salinity commonly occurs only in the surface tier. One classification unit is used to identify surface soil materials with lower salinity.

The term ripening is used for the initial soil formation processes occurring in marine deposits and peats which yield soils suitable for agriculture (Pons, etc. 1965). The initial soil formation commences with the drainage of the sediments and subsequent oxidation of the soil. New Hampshire tidal marsh soils have not been drained and hence the terms soil material and soil layer are used in this publication.

TAXONOMIC KEY OF NEW HAMPSHIRE TIDAL MARSH SOILS

The control section, its diagnostic materials and other non-diagnostic features			Classification
Surface Tier (0-12 inches)	Subsurface Tier (12-36 inches)	Bottom Tier (36-51 inches)	Great Group, Subgroup or Phase of Subgroup
More Than 10,000 PPM Salt			
Fibric	Hemic	Hemic	Typic Sulfihemists (397 map symbol)
Fibric	Hemic	Sand	Terric Sulfihemists, over sand (497 map symbol)
Fibric	Hemic	Silt	Terric Sulfihemists, over silt (597 map symbol)
Fibric	Hemic	Bedrock	Lithic Sulfihemists (697 map symbol)
Fibric	Sand	Sand	Typic Sulfaquents (797 map symbol)
Less Than 10,000 PPM Salt--surface tier			
Fibric	Hemic	Hemic or silt or sand	Sulfihemists, surface soil materials with low salt (997 map symbol)

TECHNICAL SOIL DESCRIPTIONS

A representative technical description for each of the classification units is provided for those interested in soil taxonomy. Separate notations are made for fiber content analysis using either the wet sieve or field methods. Munsell color designations are used. A description of laboratory analysis and procedures for determining selected soil properties is provided in the section,"Characterization of Soils".

Typic Sulfihemists

These soils consist of very poorly drained organic soil materials thicker than 50 inches. They occupy tidal marshes that are subject to flooding by shallow water at high tide. An important property of these soils is the presence of sulfidic materials.

A representative profile of a Typic Sulfihemist located in the town of Hampton on a high marsh position with dominant vegetation of Spartina patens is described below. The site is located in Rockingham County, New Hampshire, Town of Hampton, U.S.G.S. Hampton, New Hampshire, 7-1/2' quadrangle; 42°55'17"N and 70°49'38"W (fiber contents by wet sieve method).

Oil — 0 to 8 inches, very dark grayish brown (10YR 3/2) on both broken face and rubbed soil; the unrubbed fiber content is two-thirds of soil volume and rubbed fiber content is four-tenths; massive; non-sticky; 5 percent mineral; many fine and medium size live roots; sodium pyrophosphate extract color light gray (10YR 7/1); pH in water 6.6, after H_2O_2 treatment 3.5; total salts 29,300 ppm; abrupt, smooth boundary.

Oel — 8 to 15 inches, black (10YR 2.1) on broken face and black (5YR 2/1) on rubbed soil; the unrubbed fiber content is two-thirds of soil volume and rubbed fiber content is two-tenths; massive; slightly sticky; 10 percent mineral; fine and medium size live roots are common; sodium pyrophosphate extract color pinkish gray (7.5YR 6/2); pH in water 6.8, after H_2O_2 treatment 4.2; total salts 27,100 ppm; abrupt, smooth boundary.

Oe2 15 to 31 inches, dark reddish brown (5YR 3/2) on broken face and dark reddish brown (5YR 2/2) on rubbed soil; the unrubbed fiber content is one-half of soil volume and rubbed fiber content is two-tenths; massive; slightly sticky; 20 percent mineral; few fine live roots; sodium pyrophosphate extract color very pale brown (10YR 7/3); pH in water 7.0, after H_2O_2 treatment 3.2; total salts 27,200 ppm; abrupt, smooth boundary.

Oe3 31 to 42 inches, dark reddish brown (5YR 2/2) on broken face and black (5YR 2/1) on rubbed soil; the unrubbed fiber content is two-thirds of soil volume and rubbed fiber content is two-tenths; massive; slightly sticky; 10 percent mineral; few fine live roots; sodium pyrophosphate extract color pale brown (10YR 6/3); pH in water 6.8, after H_2O_2 treatment 3.9; total salts 25,600 ppm; gradual, smooth boundary.

Oe4 42 to 63 inches, dark reddish brown (5YR 2/2) on both broken face and rubbed soil; the unrubbed fiber content is one-half of soil volume and rubbed fiber content is one-sixth; massive; slightly sticky; 15 percent mineral; sodium pyrophosphate extract color very pale brown (10YR 7/3); pH in water 7.0, after H_2O_2 treatment 4.0; total salts 25,400 ppm.

Terric Sulfihemists, over sand

These soils consist of very poorly drained organic soil materials 16 to 50 inches in thickness overlying sandy materials. They occupy tidal marshes that are subject to flooding by shallow water at high tide. An important property of these soils is the presence of sulfidic materials.

A representative profile of a Terric Sulfihemist, over sand, located in the town of Hampton near the Taylor River with dominant vegetation of *Spartina patens* and *Distichlis spicata* is described below. The site is located in Rockingham County, New Hampshire, Town of Hampton, U.S.G.S. Hampton, New Hampshire, 7-1/2' quadrangle; 42°55'21"N and 70°55'44"W (fiber content by wet sieve method).

Oe1 0 to 7 inches, dark olive gray (5Y 3/2) on broken face and very dark grayish brown (2.5Y 3/2) on rubbed soils; the unrubbed fiber content is one-half of soil volume and rubbed fiber content is one-third; massive; slightly sticky; 10 percent mineral; many fine and medium live roots; sodium pyrophosphate extract color light gray (10YR 7/1); pH in water 6.4, after H_2O_2 treatment 5.1; total salts 27,400 ppm; abrupt, smooth boundary.

Oe2 7 to 13 inches, dark brown (10YR 3/3) on broken face and very dark grayish brown (2.5Y 3/2) on rubbed soil; the unrubbed fiber content is one-half of soil volume and rubbed fiber content is one-sixth; massive; slightly sticky; 10 percent mineral; fine and medium size live roots are common; sodium pyrophosphate extract color light gray (10YR 7/2); pH in water 7.0, after H_2O_2 treatment 5.1; total salts 29,800 ppm; abrupt, smooth boundary.

Oe3 13 to 24 inches, dark olive gray (5Y 3/2) on both broken face and rubbed soil; the unrubbed fiber content is one-third of soil volume and rubbed fiber content is one-sixth; massive; slightly sticky; 15 percent mineral; sodium pyrophosphate extract color light gray (10YR 7/2); few fine live roots; pH in water 7.2, after H_2O_2 treatment 5.1; total salts 24,800 ppm; clear, smooth boundary.

Oe4 24 to 35 inches, very dark gray (5Y 3/1) on both broken face and rubbed soil; the unrubbed fiber content is one-third of soil volume and rubbed fiber content is one-sixth; massive; slightly sticky; 20 percent mineral; sodium pyrophosphate extract pinkish gray (7.5YR 7/2); pH in water 7.2, after H_2O_2 treatment 2.9; total salts 29,500 ppm; clear, smooth boundary.

IIC1 35 to 43 inches, dark gray (5Y 4/1) and dark olive gray (5Y 3/2) fine and medium sand; single grain; non-sticky; 15 percent organic matter; pH in water 7.4, after H_2O_2 treatment 2.3; total salts 29,000 ppm; clear, smooth boundary.

IIC2 43 to 51 inches, dark gray (5Y 4/1) fine and medium sand; single grain; non-sticky; pH in water 7.8, after H_2O_2 treatment 2.6; total salts 33,000 ppm.

Terric Sulfihemists, over silt

These soils consist of very poorly drained organic soil materials 16 to 50 inches in thickness overlying silty materials. They occupy tidal marshes that are subject to flooding by shallow water at high tide. An important property of these soils is the presence of sulfidic materials.

A representative profile of a Terric Sulfihemist, over silt, located in the city of Portsmouth near Sagamore Creek with dominant vegetation of

Spartina patens, *Distichlis spicata*, *Juncus gerardii* is located in Rockingham County, New Hampshire, City of Portsmouth, U.S.G.S. Portsmouth, New Hampshire, 7-1/2' quadrangle; 43°02'58"N and 70°46'56"W (fiber content by field method). (Fig.18)

Oi1 — 0 to 5 inches, very dark grayish brown (10YR 3/2) and dark reddish brown (5YR 2/2) on broken face and dark reddish brown (5YR 2/2) on rubbed soil; the unrubbed fiber content is eight-tenths of soil volume and rubbed fiber content is four-tenths; massive; non-sticky; 5 percent mineral; many fine and medium live roots; sodium pyrophosphate extract color light gray (10YR 7/1); pH in water 6.0, after H_2O_2 treatment 4.3; total salts 18,300 ppm; abrupt, smooth boundary.

Oe1 — 5 to 17 inches, dark reddish brown (5YR 2/2) on broken face and very dusky red (2.5YR 2/2) on rubbed soil; the unrubbed fiber content is eight-tenths of soil volume and rubbed fiber content is three-tenths; massive; slightly sticky; 5 percent mineral; fine and medium size live roots are common; sodium pyrophosphate extract color light gray (10YR 7/2); pH in water 6.4, after H_2O_2 treatment 4.0; total salts 20,600 ppm; clear, smooth boundary.

Oe2 — 17 to 38 inches, dark reddish brown (5YR 2/2) on both broken face and rubbed soil; the unrubbed fiber content is six-tenths of soil volume and rubbed fiber content is one-fourth; massive; slightly sticky; 5 percent mineral; few fine and medium live roots; sodium pyrophosphate extract color pale brown (10YR 6/3); pH in water 6.4, after H_2O_2 treatment 4.0; total salts 23,100 ppm; abrupt, smooth boundary.

IIC1 — 38 to 42 inches, very dark gray (5Y 3/1) silty clay loam; massive; slightly sticky; pH in water 6.8, after H_2O_2 treatment 4.6; total salts 22,100 ppm; abrupt, smooth boundary.

IIC2 — 42 to 47 inches, dark gray (N4) silty clay loam; massive; slightly sticky; pH in water 7.0; abrupt, smooth boundary.

IIC3 — 47 to 51 inches, dark greenish gray (5G 4/1) clay; massive; slightly sticky; pH in water 7.2.

Lithic Sulfihemists

These soils consist of very poorly drained organic soil materials 16 to 50 inches in thickness overlying bedrock. They occupy tidal marshes that are subject to flooding by shallow water at high tide.

A representative profile of a Lithic Sulfihemist located in the town of Rye near Seavey's Creek with dominant vegetation of *Puccinellia maritima*, *Juncus gerardii*, and *Spartina patens* is described below. The site is located in Rockingham County, New Hampshire, Town of Rye, U.S.G.S. Kittery, Maine, 7-1/2' quadrangle; 43°02'28"N and 70°43'34"W (fiber by wet sieve method).

Oe1	0 to 4 inches, black (10YR 2/1) on broken face and very dark gray (10YR 3/1) on rubbed soil; the unrubbed fiber content is two-thirds of soil volume and rubbed fiber content is one-third; massive; non-sticky; 5 percent mineral; fine and medium live roots are common; sodium pyrophosphate extract color light gray (10YR 7/1); pH in water 6.8; abrupt, smooth boundary.
Oe2	4 to 8 inches, very dark grayish brown (10YR 3/2) on both broken face and rubbed soil; the unrubbed fiber content is two-thirds of soil volume and rubbed fiber content is one-third; massive; non-sticky; 5 percent mineral; fine and medium size live roots are common; sodium pyrophosphate extract color light gray (10YR 7/1); pH in water 6.6; abrupt, wavy boundary.
Oe3	8 to 15 inches, very dark gray (5YR 3/1) on both broken face and rubbed soil; the unrubbed fiber content is two-thirds of soil volume and rubbed fiber content is one-fourth; massive; non-sticky; 5 percent mineral; few fine and medium size live roots; sodium pyrophosphate extract color light gray (10YR 7/2); pH in water 6.6; clear, smooth boundary.
Oe4	15 to 30 inches, very dark gray (10YR 3/1) on broken face and dark reddish brown (5YR 3/2) on rubbed soil; the unrubbed fiber content is one-third of soil volume and the rubbed fiber content is one-fifth; massive; non-sticky; 5 percent mineral; few fine and medium size live roots; sodium pyrophosphate extract color is pinkish gray (7.5YR 6/2); pH in water 6.4; clear, smooth boundary.
Oe5	30 to 47 inches, dark reddish brown (5YR 3/2) on both broken face and rubbed soil; the unrubbed fiber content is one-third of soil volume and rubbed fiber content is one-fifth; massive; non-sticky; 10 percent mineral; few fine and medium size live roots; sodium pyrophosphate extract color is pinkish gray (7.5YR 6/2); pH in water 6.4; abrupt, smooth boundary.
IIR	Bedrock.

Typic Sulfaquents

These soils consist of very poorly drained mineral soils with less than 16 inches of organic soil materials overlying sandy materials. They occupy tidal marshes that are subject to flooding by shallow water at high tide. An important property of these soils is the presence of sulfidic materials.

A representative profile of a Typic Sulfaquent located in the town of Seabrook with dominant vegetation of Spartina patens (40 percent), Puccinellia paupercula (30 percent), and Salicornia virginica (25 percent) is described below. The site is located in Rockingham County, New Hampshire, Town of Seabrook, U.S.G.S. Hampton, New Hampshire, 7-1/2' quadrangle; 42°53'02"N and 70°49'21"W (fiber content by wet sieve method).

01 9 to 5 inches, dark brown (7.5YR 3/2) on broken face and very dark gray (10YR 3/1) on rubbed soil; the unrubbed fiber content is two-thirds of soil volume and rubbed fiber content is one-fourth; massive; non-sticky; 10 percent mineral; many fine and medium live roots; sodium pyrophosphate extract color light gray (10YR 7/1); pH in water 7.0, after H_2O_2 treatment 4.8; total salts 19,600 ppm; clear, smooth boundary.

02 5 to 0 inches, very dark grayish brown (2.5Y 3/2) on both broken face and rubbed soil; the unrubbed fiber content is one-half of soil volume and rubbed fiber content is one-tenth; massive; slightly sticky; 20 percent mineral; fine and medium size live roots are common; sodium pyrophosphate extract color light gray (10YR 7/1); pH in water 6.8; after H_2O_2 treatment 4.2; total salts 27,600 ppm; abrupt, smooth boundary.

C1 0 to 6 inches, dark grayish brown (10YR 4/2) medium sand with many medium distinct dark brown (7.5YR 4/4) mottles; single grain; non-sticky; few fine live roots; pH in water 6.8; total salts 28,600 ppm; clear, smooth boundary.

C2 6 to 19 inches, gray (5Y 5/1) fine sand; single grain; non-sticky; pH in water 6.6; total salts 27,600 ppm; abrupt, smooth boundary.

C3 19 to 27 inches, light olive brown (2.5Y 5/4) very coarse sand; single grain; non-sticky; pH in water 6.6; total salts 30,000 ppm; abrupt, smooth boundary.

C4 27 to 42 inches, grayish brown (2.5Y 5/2) medium sand; single grain; non-sticky; pH in water 6.6.

Sulfihemists, surface soil materials with low salt

These soils consist of very poorly drained organic soil materials thicker than 50 inches, or organic soil materials 16 to 50 inches thick overlying sand or silt materials. They occupy estuaries and tidal marshes that commonly are subject to the influence of fresh waters from adjoining uplands. Total salt concentrations in the surface soil materials are lower than other tidal marsh soils. An important property of these soils is the presence of sulfidic materials.

A representative profile of a Sulfihemist, surface soil materials with low salt, located in the town of Stratham along Mill Brook with a vegetation association dominated by Spartina patens and including Spartina pectinata is described below. The site is located in Rockingham County, New Hampshire, Town of Stratham, U.S.G.S. Newmarket, New Hampshire, 7-1/2' quadrangle; 43°02'12"N and 70°55'36"W (fiber content by field method).

Oi1 0 to 4 inches, dark gray (5Y 5/1) on both broken face and rubbed soil; the unrubbed fiber content is eight-tenths of soil volume and rubbed fiber content is six-tenths; massive; non-sticky; 10 percent mineral; many fine and medium size live roots; sodium pyrophosphate extract white (10YR 8/1); pH in water 6.4, after H_2O_2 treatment 3.9; total salts 5,000 ppm; clear, wavy boundary.

Oi2 4 to 12 inches, dark grayish brown (10YR 4/2) on broken face and dark grayish brown (2.5Y 4/2) on rubbed soil; the unrubbed fiber content is eight-tenths of soil volume and rubbed fiber content is four-tenths; massive; non-sticky; 5 percent mineral; 5 percent coarse fragments; many fine and medium size live roots; sodium pyrophosphate extract light gray (10YR 7/1); pH in water 6.6, after H_2O_2 treatment 5.6; total salts 7,500 ppm; abrupt, smooth boundary.

Oe1 12 to 19 inches, black (10YR 2/1) on broken face and very dark gray (5Y 3/1) on rubbed soil; the unrubbed fiber content is two-thirds of soil volume and rubbed fiber content is two-tenths; massive; non-sticky; 15 percent mineral; fine and medium size live roots are common; sodium pyrophosphate extract light gray (10YR 7/2); pH in water 6.5, after H_2O_2 treatment 5.9; total salts 12,800 ppm; abrupt, smooth boundary.

Oe2 19 to 27 inches, very dark grayish brown (10YR 3/2) on broken face and very dark gray (10YR 3/1) on rubbed soil; the unrubbed fiber content is two-thirds of soil volume and rubbed fiber content is two-tenths; massive; non-sticky; 5 percent mineral; few fine and medium live roots; sodium pyrophosphate extract very pale brown (10YR 7/3); pH in water 7.1, after H_2O_2 treatment 5.6; total salts 17,900 ppm; abrupt, smooth boundary.

Oe3 27 to 34 inches, black (10YR 2/1) on both broken face and rubbed soil; the unrubbed fiber content is one-half of soil volume and rubbed fiber content is one-sixth; massive; non-sticky; 5 percent mineral; sodium pyrophosphate extract light brownish gray (10YR 6/2); pH in water 6.9, after H_2O_2 treatment 4.1; total salts 20,600 ppm; clear, wavy boundary.

Oe4 34 to 44 inches, very dark grayish brown (10YR 3/2) on broken face and very dark gray (10YR 3/1) on rubbed soil; the unrubbed fiber content is one-half of soil volume and rubbed fiber content is one-sixth; massive; non-sticky; 10 percent mineral; sodium pyrophosphate extract pinkish gray (7.5YR 6/2); pH in water 7.1, after H_2O_2 treatment 3.2: total salts 29,100 ppm; clear, wavy boundary.

Oe5 44 to 50 inches, very dark grayish brown (10YR 3/2) on broken face and dark grayish brown (10YR 4/2) on rubbed soil; the unrubbed fiber content is one-half of soil volume and rubbed fiber content is one-sixth; massive; non-sticky; 5 percent mineral; sodium pyrophospahte extract pinkish gray (7.5YR 6/2); pH in water 7.0; after H_2O_2 treatment 3.8; total salts 28,100 ppm; clear, wavy boundary.

Oe6 50 to 65 inches, very dark grayish brown (2.5Y 3/2) on both broken face and rubbed soil; the unrubbed fiber content is four-tenths of soil volume and rubbed fiber content is one-sixth; massive; non-sticky; 5 percent mineral; 5 percent woody coarse fragments; sodium pyrophosphate extract pale brown (10YR 6/3); pH in water 7.0, after H_2O_2 treatment 2.8; total salts 37,900 ppm.

CHARACTERIZATION OF SOILS

The 1970 study area consisted of the nearly level tidal marshes bordering the Atlantic Ocean coastline north of Portsmouth to the Piscataqua River and south of Portsmouth to Seabrook, New Hampshire. Exploratory traverses of the marsh were made in advance of the sampling dates to determine the morphological character of the soils most generally occurring. Sites were selected for careful morphological study and for sampling to obtain needed laboratory data for classification and interpretations. Representative sites were selected on basis of kind of organic soil materials, thickness of layers, depth of organic tiers to mineral material. Laboratory data for three sites are presented in Tables 1, 2 and 3.

The first site was located in the Seabrook Marsh. At low tide the water level is about 5 feet below the surface and at normal high tide the water is a few inches below the surface. Samples were obtained to a depth of 42 inches from a pit and with a McCauley peat sampler below this depth. A detailed soil description of this pedon (S70NH-10-1) is provided in appendix B. The soil is organic to a depth of 305 cm (120 inches) consisting mainly of fibric and hemic materials. The pH values were slightly above and below 6.0 throughout. The underlying mineral material consisted of dark colored sand. Tests for potential sulfur acidity showed a considerable drop in pH following hydrogen peroxide treatment. This pedon is classed as having moderate potential sulfur acidity. The salt content of a water sample taken nearby is 3.3 percent or 33,000 ppm. Water content of the organic material was 177 percent in the surface and increased to 433 percent to a depth of 93 inches.

The second site was located in the town of Rye on the R. L. Brown property. Sampling was done with McCauley peat sampler. A detailed description of this pedon (S70NH-10-2) is provided in appendix B. This pedon is composed of organic material to a depth of 305 cm (120 inches). The surface had a pH of 5.4 and underlying layers have pH values ranging from 6.2 to 6.4. The salt content of the water near the site was 2.9 percent or 29,000 ppm. The pH drop following hydrogen peroxide treatment indicates moderate potential sulfur acidity for all but one layer which was high.

The third site was also located on the Seabrook Marsh and consisted of organic layers to a depth of 102 cm (40 inches) overlying a silt loam material with some clam shells. Samples were obtained from a pit. A detailed description of this pedon (S70NH-10-3) is provided in appendix B. All layers were classified as fibric except for the one immediately above the mineral layer which was classed as hemic. Except for the surface layer, pH values of organic layers ranged from 6.4 to 6.7. The mineral soil had a pH value of 6.9. The potential sulfur acidity was moderate throughout, but values are higher in the 12 - 80 cm (5 to 32 inches) depth indicating some effect of the calcareous clam shells in the lower horizon. The salt content of the water at this site, 3.3 percent or 33,000 ppm, is identical with the first site which was in the same area.

1973 Survey

To permit the classification of tidal marsh soils and to provide data for the soil interpretations, the laboratory examination of certain physical and chemical properties was essential. Samples for analysis were taken from each horizon, immediately placed in sealed plastic bags, and kept sealed until reopening for analysis in the laboratory. Collection of samples for analysis began in late September when laboratory facilities and the services of a lab technician were made available by the Universit of New Hampshire. The following describes the analyses made, and procedures followed.

Soil Reaction

Using standard indicator solutions, the pH of all pedons was measured at the time of writing the profile descriptions. Later, as samples for laboratory analysis were collected, a 10-gram portion from each horizon of each pedon was mixed with 30 ml. of distilled water and its pH measured using a Fisher Model 520 Digital pH/ion meter. Then, a 5-gram portion of each horizon was treated with 20 ml. of hydrogen peroxide (30% solution) and heated over a water bath to oxidize any sulfidic material. Upon completion of oxidation, the pH was measured as before and the change in pH gave an indication of the amount of sulfidic material present. Soils rich in calcium, as well as sulfides, show little change in pH after treatment (Beers 1962) and (Bloomfield & Coulter, 1973). The results of these tests support the field identification of these soils as containing sulfidic material and their classification as Sulfihemists.

Salinity

Salinity was determined by the saturation-extraction method. About 20 ml. of water was extracted from each sealed sample brought in from the field and placed in a sealed container. The salinity of each sample, in ppt, was measured by a Refractometer/Salinometer, Type 102, and recorded.

Percent Organic Matter

The percent organic matter of pedons was determined in the field by examination and randomly selected samples were checked in the lab using the loss on ignition method. Samples were oven dried at 110°C for 24 hours, weighed, placed in a muffle furnace at 500°C for 4 hours, and weighed again after cooling.

Percent Fiber Content

The fiber content of each pedon was determined by examination in the field and selected samples were checked in the lab by the wet sieve method. The volume of a sample was measured by a graduated cylinder. The sample was then placed on an 8-inch, 200 mesh standard sieve, washed under running water until the effluent was clear, and then the volume remeasured. Similarly, duplicate samples were rubbed 10 times between thumb and fingers, after initial measurement, then washed and remeasured.

Particle Size Analysis

The particle size distribution of the mineral horizons of certain pedons was caluclated by the Bouyoucos Method as a check on the field determination of soil texture.

State of Decomposition of Fibers

Classification of organic soils (Histosols) is, in part, dependent on the state of decomposition of plant parts and measured by the fiber content of the undisturbed soil and the fiber content after rubbing. In addition to wet sieving, the sodium pyrophosphate test was used on selected samples for this determination. In this method, an approximate 5-gram sample of soil is mixed with 10 ml. of distilled water in a test tube and a pea-size crystal of sodium pyrophosphate is added. A strip of chromatographic paper is inserted in the tube and allowed to stand for 12 hours. The paper strip is then removed and the color, by Munsell Notation, is recorded. The range of colors diagnostic for the suborders of Histosols is defined in Soil Taxonomy. The results of these analyses are listed in Tables 4 and 5.

TABLE 1 -- 1970 Study[1/]

Chemical Properties of Selected Soils

Soil and sample number	Horizon	Depth from Surface	Organic Matter[2/]	Resis-tivity Ohms-cm 60°F	SO4 Water Soluble	Total Sulfur
		inches	percent		Meg./1	percent
Typic Sulfihemists						
S70NH-10-1	Oa1	0-5	26.6	80	--	--
	Oe1	5-9	14.0	80	43.7	0.1
	Oe2	9-11	16.7	90	39.8	--
	Oi1	11-17	19.3	90	54.8	1.1
	Oi2	17-34	23.4	80	160.3	0.7
	Oe3	34-42	19.7	80	219.9	--
	Oi3	42-70	39.8	80	168.6	1.2
	Oi4[3/]	70-83	59.6	--	213.4	2.3
	Oe4	83-93				
	Oe5	93-120	42.7	--	184.5	1.3
	IIC	120-135	2.7	--	223.7	0.7
Typic Sulfihemists, fibric subsurface tier						
S70NH-10-2	Oi1	0-20	54.4	90	117.5	0.9
	Oi2	20-43	46.4	100	97.5	0.9
	Oe1	43-53	29.8	100	89.4	0.7
	Oi3	53-72	51.2	90	67.7	--
	Oi4	72-96	68.6	300	65.5	0.9
	Oi5	96-120	31.7	300	107.8	--
Terric Sulfihemists, over silt, fibric subsurface tier						
S70NH-10-3	Oi1	0-5	28.5	100	143.6	--
	Oi2	5-11	13.4	100	170.5	1.0
	Oi3	11-24	16.9	100	204.0	--
	Oi4	24-32	18.5	100	132.9	--
	Oe1	32-40	21.7	100	136.2	0.5
	IIC	40-72	7.3	100	223.9	0.6

Horizon	Extractable Bases (milliequivalents per 100 grams of soil) Ca	Mg	Na	K	Sum	Extractable Acidity	Cation Exchange Capacity (sum)
						Meg./100 gm.	Meg./100 gm.
Oa1	12.6	34.0	105.4	3.9	155.9	9.8	36.8
Oe1	10.6	31.7	104.0	3.3	149.6	9.0	32.3
Oe2	12.0	34.1	111.9	3.1	161.1	11.0	30.8
Oi1	12.4	38.8	135.1	3.4	189.7	13.8	30.3
Oi2	10.7	33.6	115.0	3.5	162.8	32.6	27.5
Oe3	9.2	30.2	108.8	3.3	151.5	37.0	26.8
Oi3	18.0	55.2	176.7	4.6	254.5	75.6	42.7
Oi4	21.9	64.4	217.7	5.1	308.8	135.5	52.0
Oe4							
Oe5	20.3	64.6	219.2	5.3	309.4	102.2	42.0
IIC	3.3	6.8	21.0	0.6	31.7	25.7	4.9
Oi1	10.2	34.8	121.6	3.4	170.0	36.0	26.9
Oi2	14.1	43.2	143.5	4.0	204.8	64.0	40.2
Oe1	21.2	47.1	123.3	4.0	195.6	38.0	42.7
Oi3	34.8	43.8	86.8	2.6	168.0	60.1	56.7
Oi4	36.7	41.7	44.4	1.4	124.2	79.8	54.8
Oi5	26.7	27.3	19.4	1.0	74.4	71.5	38.1
Oi1	9.7	34.6	128.2	4.1	176.6	33.7	26.0
Oi2	10.7	37.0	134.0	3.6	185.3	36.1	20.4
Oi3	8.4	29.3	106.8	3.4	147.9	24.1	18.7
Oi4	11.0	37.6	126.7	3.7	179.0	37.2	28.2
Oe1	7.6	28.5	98.4	3.5	138.0	19.4	18.5
IIC	10.8	13.9	39.8	2.2	66.7	20.1	12.1

1/ Determined by the Soil Survey Laboratory, Beltsville, Maryland.
2/ Loss on ignition at 400°C in a muffle furnace.
3/ The 70- to 83-inch and 83- to 93-inch depths were combined for sampling.

TABLE 2 -- 1970 Study

Results of the potential sulfur acidity test on New Hampshire Tidal Marsh Soils[1/]

Horizon	Depth Inches	pH before H_2O_2 treatment	pH after H_2O_2 treatment	Potential sulfur acidity[2/] class (pH drop)	Meq. potential acidity per 100g soil	Est. sulfur content Pct.	Water content Pct.
SOIL:	S70NH-10-1	Typic Sulfihemist					
Oa1	0-5	6.25					
Oe1	5-9	6.15	2.9	Mod.	92	1.5	177
Oe2	9-11	6.12	2.7	Mod.	98	1.6	246
Oi1	11-17	6.08					
Oi2	17-34	6.05	2.3	Mod.			
Oe3	34-42	6.12					
Oi3	42-70	6.12	2.4	Mod.	233	3.7	312
Oi4	70-83	5.85	2.4	Mod.	223	3.6	433
Oe4	83-93	5.85	2.1	High	216	3.4	263
Oe5	93-120	6.02	3.2	Low	21	0.3	368
IIC	120-135	5.98					
SOIL:	S70NH-10-2	Typic Sulfihemist, fibric subsurface tier					
Oi1	0-20	5.45					
Oi2	20-43	6.25	2.25	Mod.			
Oe1	43-53	6.40	2.5	Mod.	412	6.6	944
Oi3	53-72	6.32					
Oi4	72-96	6.20	2.0	High			
Oi5	96-120	6.25	2.4	Mod.	185	3.0	585
SOIL:	S70NH-10-3	Terric Sulfihemist, over silt, fibric subsurface tier					
Oi1	0-5	5.08	2.8	Mod.	128	2.0	232
Oi2	5-11	6.42	2.6	Mod.	145	2.3	257
Oi3	11-24	6.55	2.6	Mod.	143	2.3	248
Oi4	24-32	6.72	2.6	Mod.	140	2.2	303
Oe1	32-40	6.60	2.8	Mod.	70	1.1	186
IIC	40-72	6.90	3.0	Mod.	23	0.4	832

1/ Determined by the Soil Survey Laboratory, Beltsville, Md.
2/ Classes of sulfur acidity are based on the pH attained after H_2O_2 treatment of a 5 cc sample as follows:

pH 3	low or none
pH 2.2-3.0	Mod.
pH 2.2	High

TABLE 3 -- 1970 Study

pH of New Hampshire tidal marsh soils in the field, after drying 18 days and after hydrogen peroxide oxidation. 1/

Horizon	Depth Inches	pH Wet Soil In Field	pH After Drying 18 Days	pH After H_2O_3 Oxidation
S70NH-10-1	Typic Sulfihemist			
Oa1	0-5	6.2	6.2	
Oe1	5-9	6.2	6.1	2.9
Oe2	9-11	6.1	5.9	2.7
Oi1	11-17	6.1	5.7	
Oi2	17-34	6.0	4.1	2.3
Oe3	34-42	6.1	3.2	
Oi3	42-70	6.1	3.1	2.4
Oi4	70-83			
Oe4	83-93	5.6	2.6	2.4
Oe5	93-120	6.0	3.0	2.1
IIC	120-135	6.0	3.5	3.2
S70NH-10-2	Typic Sulfihemist, fibric subsurface tier			
Oi1	0-20	5.4	3.2	
Oi2	20-43	6.2	3.8	2.2
Oe1	43-53	6.4	4.1	2.5
Oi3	53-72	6.3	3.8	
Oi4	72-96	6.2	4.2	2.0
Oi5	96-120	6.2	3.9	2.4
S70NH-10-3	Terric Sulfihemist, over silt, fibric subsurface tier			
Oi1	0-5	5.1	4.1	2.0
Oi2	5-11	6.4	3.7	2.6
Oi3	11-24	6.6	3.0	3.6
Oi4	24-32	6.7	2.7	2.6
Oe1	32-40	6.6	3.8	2.8
IIC	40-73	6.9	3.3	3.0

1/ Determined by the Soil Survey Laboratory, Beltsville, Md.

TABLE 4 -- 1973 Study

Some Physical Properties of Selected Soils

Soil and Sample Number	Horizon	Depth from Surface	Unrubbed	Rubbed	Organic Matter	Particle Size Distribution: Sand (0.05 to 2 mm)	Silt (0.002 to 0.05 mm)	Clay (0.002 mm)
		Inches	Fraction	Fraction	Percent	Percent	Percent	Percent
Typic Sulfihemist TM-12	Oi1	0-8	2/3	4/10	47.3	--	--	--
	Oe1	8-15	2/3	2/10	39.0	--	--	--
	Oe2	15-31	1/2	2/10	35.8	--	--	--
	Oe3	31-42	2/3	2/10	52.2	--	--	--
	Oe4	42-63	1/2	1/6	--	--	--	--
Terric Sulfihemist, over sand TM-36	Oe1	0-7	1/2	1/3	35.8	--	--	--
	Oe2	7-13	1/2	1/6	45.0	--	--	--
	Oe3	13-24	1/3	1/6	35.4	--	--	--
	Oe4	24-35	1/3	1/6	20.5	--	--	--
	IIC1	35-43	--	--	--	82	16	2
	IIC2	43-51	--	--	--	84	14	2
Typic Sulfaquent TM-41	Oe1	0-4	2/3	1/4	57.9	--	--	--
	Oe2	4-9	1/2	1/10	48.5	--	--	--
	IIC1	9-15	--	--	5.8	92	7	<1
	IIC2	15-28	--	--	--	94	5	<1
	IIC3	28-36	--	--	--	--	--	--
	IIC4	36-51	--	--	--	--	--	--
Terric Sulfihemist, over sand TM-42	Oe1	0-3	2/3	1/3	58.3	--	--	--
	Oe2	3-6	1/2	2/10	42.6	--	--	--
	Oe3	6-14	2/3	1/3	64.5	--	--	--
	Oe4	14-28	2/3	1/4	62.5	--	--	--
	Oa1	28-37	1/3	1/10	48.6	--	--	--
	IIC1	37-41	--	--	--	77	20	3
	IIC2	41-56	--	--	--	81	17	2
Typic Sulfihemist TM-45	Oi1	0-7	2/3	1/2	73.8	--	--	--
	Oe1	7-11	1/2	1/4	48.1	--	--	--
	Oe2	11-14	1/3	1/6	36.3	--	--	--
	Oe3	14-35	1/2	1/4	38.0	--	--	--
	Oe4	35-54	1/3	1/6	28.1	--	--	--
	IIC1	54-60	--	--	--	73	22	5
Typic Sulfihemist TM-46	Oi1	0-5	2/3	1/3	69.6	--	--	--
	Oe1	5-10	1/3	1/6	35.2	--	--	--
	Oe2	10-19	1/2	1/4	34.3	--	--	--
	Oe3	19-36	1/2	1/4	35.3	--	--	--
	Oe4	36-61	1/3	1/6	29.0	--	--	--
Terric Sulfihemist, over sand TM-51	Oe1	0-4	2/3	1/3	65.2	--	--	--
	Oe2	4-10	1/2	1/4	51.7	--	--	--
	Oe3	10-11	1/2	1/4	35.7	--	--	--
	Oe4	11-31	1/2	1/4	55.4	--	--	--
	Oe5	31-44	1/3	1/6	--	--	--	--
	IIC1	44-56	--	--	--	--	--	--
Typic Sulfihemist TM-55	Oi1	0-7	3/4	1/2	60.0	--	--	--
	Oe1	7-12	1/3	1/6	30.2	--	--	--
	Oe2	12-23	1/2	1/4	41.4	--	--	--
	Oe3	23-43	1/2	1/4	51.6	--	--	--
	Oe4	43-63	1/2	1/6	40.8	--	--	--
Terric Sulfihemist, over silt TM-59	Oe1	0-7	1/2	1/3	42.2	--	--	--
	Oe2	7-23	1/2	1/4	43.0	--	--	--
	Oe3	23-37	1/3	1/6	28.3	--	--	--
	IIC1	37-52	--	--	--	21	73	6
Terric Sulfihemist, over sand TM-69	Oi1	0-7	2/3	1/2	59.0	--	--	--
	Oe1	7-10	2/3	1/3	61.7	--	--	--
	Oe2	10-20	1/3	1/6	47.4	--	--	--
	IIC1	20-30	--	--	--	73	23	4
	IIC2	30-52	--	--	--	81	18	<1

TABLE 4 (Cont.)

Soil and Sample Number	Horizon	Depth from Surface	Unrubbed	Rubbed	Organic Matter	Particle Size Distribution: Sand (0.05 to 2 mm)	Silt (0.002 to 0.05 mm)	Clay (0.002 mm)
		Inches	Fraction	Fraction	Percent	Percent	Percent	Percent
Terric Sulfihemist, over silt								
TM-77	Oi1	0-5	2/3	1/3	63.0	--	--	--
	Oe1	5-10	1/2	1/5	34.1	--	--	--
	Oe2	10-14	1/2	1/4	36.8	--	--	--
	Oe3	14-33	1/2	1/5	37.1	--	--	--
	Oe4	33-38	1/2	1/6	33.4	--	--	--
	IIC1	38-51	--	--	--	14	75	11
Lithic Sulfihemist	Oe1	0-4	2/3	1/3	59.8	--	--	--
TM-78	Oe2	4-8	2/3	1/3	65.2	--	--	--
	Oe3	8-15	2/3	1/4	67.7	--	--	--
	Oe4	15-30	1/3	1/5	55.4	--	--	--
	Oe5	30-47	1/3	1/5	53.9	--	--	--
Typic Sulfihemist								
TM-92	Oi1	0-4	2/3	1/3	59.7	--	--	--
	Oi2	4-6	2/3	1/3	70.0	--	--	--
	Oe1	6-13	1/2	1/4	38.0	--	--	--
	Oe2	13-32	1/3	1/5	25.1	--	--	--
	Oe3	32-53	1/3	1/6	21.4	--	--	--
	IIC1	53-60	--	--	--	14	75	11

TABLE 5 -- 1973 Study

Some Chemical Properties of Selected Soils

Soil and Sample Number	Horizon	Depth from Surface	Salinity	Reaction: Before oxidation	Reaction: After oxidation	Sodium Pyrophosphate Test
		Inches	ppm	pH	pH	Munsell Notation
Sulfihemists, surface soil materials with low salt TM-2	Oi1	0-4	5,000	6.4	3.9	10YR 8/1
	Oi2	4-12	7,500	6.6	5.6	10YR 7/1
	Oe1	12-19	12,800	6.5	5.9	10YR 7/2
	Oe2	19-27	17,900	7.1	5.6	10YR 7/3
	Oe3	27-34	20,600	6.9	4.1	10YR 6/2
	Oe4	34-44	29,100	7.1	3.2	7.5YR 6/2
	Oe5	44-50	28,100	7.0	3.8	7.5YR 6/2
	Oe6	50-65	37,900	7.0	2.8	10YR 6/3
Typic Sulfihemist TM-12	Oi1	0-8	29,300	6.6	3.5	10YR 7/1
	Oe1	8-15	27,100	6.8	4.2	7.5YR 6/2
	Oe2	15-31	27,200	7.0	3.2	10YR 7/3
	Oe3	31-42	25,600	6.8	3.9	10YR 6/3
	Oe4	42-63	25,400	7.0	4.0	10YR 7/3
Typic Sulfihemist TM-13	Oi1	0-8	21,800	6.6	3.3	10YR 7/1
	Oe1	8-15	25,100	6.8	4.2	7.5YR 6/2
	Oe2	15-39	22,000	6.8	3.6	7.5YR 6/2
	Oe3	39-55	22,800	6.8	3.9	7.5YR 7/3
Terric Sulfihemist, over silt TM-16	Oi1	0-5	18,300	6.0	4.3	10YR 7/1
	Oe1	5-17	20,600	6.4	4.0	10YR 7/2
	Oe2	17-38	23,100	6.4	4.0	10YR 6/3
	IIC1	38-42	22,100	6.8	4.6	--
Terric Sulfihemist, over sand TM-36	Oe1	0-7	27,400	6.4	5.1	10YR 7/1
	Oe2	7-13	29,800	7.0	5.1	10YR 7/2
	Oe3	13-24	24,800	7.2	5.1	10YR 7/2
	Oe4	24-35	29,500	7.2	2.9	7.5YR 7/2
	IIC1	35-43	29,000	7.4	2.3	--
	IIC2	43-51	33,000	7.8	2.6	--
Typic Sulfaquent TM-41	Oe1	0-4	19,600	7.0	4.8	10YR 7/1
	Oe2	4-9	27,600	6.8	4.2	10YR 7/1
	IIC1	9-15	28,600	6.8	--	--
	IIC2	15-28	27,600	6.6	--	--
	IIC3	28-36	30,000	6.6	--	--
Typic Sulfihemist TM-46	Oi1	0-5	20,300	6.2	3.5	10YR 7/1
	Oe1	5-10	23,300	6.8	4.2	10YR 7/3
	Oe2	10-19	22,100	7.0	3.6	10YR 6/2
	Oe3	19-36	21,600	7.0	3.8	7.5YR 6/2
	Oe4	36-61	22,600	6.1	2.7	7.5YR 6/2
Typic Sulfihemist TM-57	Oi1	0-6	33,000	6.4	4.0	10YR 7/2
	Oe1	6-13	41,000	7.6	3.8	10YR 7/2
	Oe2	13-27	31,600	7.4	3.8	10YR 7/3
	Oe3	27-46	32,400	7.4	2.8	7.5YR 6/2
	Oe4	46-55	31,800	7.2	3.2	7.5YR 6/2
Typic Sulfihemist TM-73	Oi1	0-4	--	6.0	4.5	10YR 8/1
	Oi2	4-10	26,700	6.1	4.1	10YR 7/1
	Oe1	10-24	26,300	6.6	3.4	10YR 7/3
	Oe2	24-45	28,000	6.3	3.7	10YR 6/2
	Oe3	45-63	28,800	6.5	3.5	10YR 6/2
Typic Sulfihemist TM-92	Oi1	0-4	20,000	5.5	4.3	7.5YR 7/2
	Oi2	4-6	22,100	5.8	3.7	10YR 7/1
	Oe1	6-13	18,400	6.1	4.0	10YR 6/2
	Oe2	13-32	17,900	6.6	4.1	10YR 6/2
	Oe3	32-53	22,600	5.9	3.1	10YR 6/2
	IIC1	53-60	21,200	6.0	3.3	--
Typic Sulfihemist, surface soil materials with low salt TM-93	Oi1	0-8	9,700	6.1	5.0	10YR 7/2
	Oe1	8-16	23,400	5.8	2.6	10YR 6/2
	Oe2	16-30	12,500	5.5	2.7	7.5YR 6/2
	Oe3	30-36	13,900	6.5	2.7	7.5YR 6/2
	IIC1	36-52	9,000	6.6	2.8	--

HOW THIS SURVEY WAS MADE

This survey was made to determine the properties of the different kinds of soils that occupy the tidal marshes of New Hampshire, where they are located, and how they can be used. The survey party consisted of an interdisciplinary team of soil scientists and a botanist. The survey was conducted in four phases: first, a reconnaissance of the entire area; secondly, detailed examination and description of soils and vegetation, including the collecting of soil samples and plant specimens; thirdly, verification of soils data by field checks and the laboratory analysis of samples; and lastly, the final drafting of soil boundaries and symbols on base maps.

The primary objective of the reconnaissance was to obtain information that would be useful in establishing a preliminary soil survey legend. The many anticipated obstacles to conducting a reconnaissance of the area proved a reality. Drainage ditches, creeks, flooding tidal waters, hidden holes and "soft areas" on the marsh provided ample diversion from the routine task of making observations and recording notes. The dense fibrous peaty surface tier generally provided firm support for walking on the marsh. However, rubber hip boots were standard footwear to navigate along and across creeks and ditches. Ditchbanks were generally found to be quite stable; however, an occasional eroded bank provided an excellent opportunity to observe a soil profile.

A tile spade and an 8-foot steel sounding rod (a converted peat sampler with 4-foot extensions) provided the basic sampling tools for the reconnaissance. The tile spade was necessary to break through the dense fibrous surface mat that commonly is 12 to 18 inches in thickness. Observations were normally made to depths of 3 feet with the tile spade.

The New Hampshire tidal marshes and estuaries are an aggregate of many individual, distinct marshes ranging from a few tens of acres up to about 2,000 acres in size. The reconnaissance provided an opportunity to make observations on all the larger marshes and estuaries, and some of the smaller ones. The survey party accumulated extensive field notes during the reconnaissance. USGS quadrangle sheets and aerial photographs also provided a basis for recording information. Sufficient notes and observations were made to develop the following very broad generalizations:

1. On the coastal marshes the underlying mineral horizon was dominantly sand; on the estuarine marshes, it was dominantly silty.
2. The landward and seaward margins of the coastal marsh and strips bordering the larger estuaries were commonly shallow; i.e., less than 50 inches to mineral; other parts of the marsh were generally deep; i.e., over 50 inches of organic soil material.
3. The long marshes along the smaller streams feeding into Great Bay were deep, while those marshes along the banks of the larger streams and the Bay itself tended to be shallow.
4. Vegetation was a good indicator of salinity of the surface horizons and of the duration of flooding by tidal waters. It was also indicative of minor variations in elevation and of surface drainage.
5. Vegetation was not a reliable indicator of depth or texture of underlying mineral.

Based on these assumptions, tentative soil mapping units were established and the mapping, sampling, and description phases were then carried out.

Special conventions for mapping these soils and testing the mapping units were an integral part of this survey. The procedure used in making the soil survey centered on the preparation of profile descriptions (Fig. 19). Ninety-three profile descriptions were prepared in the conduct of the survey, about one description per 75 acres of survey area. Soil samples were taken from 32 pedons for laboratory analysis.

The reconnaissance of the area provided useful information in the selection of sites for profile descriptions. A careful attempt was made to select both representative pedons and pedons that would provide a range in properties. Several sampling tools were tested during the initial period of the survey. The combination of sampling tools that was most effective included a tile spade and either the McCauley peat sampler or a bucket auger. The finely machined McCauley peat sampler provided excellent soil samples. However, it required constant maintenance from the salty environment of the marsh and was a cumbersome instrument for a two-man team. A standard 3-inch bucket auger was generally used to obtain soil samples in the lower part of the control section.

A series of grids and transects was run to determine the reliability of the mapping units and the location of soil boundaries. The transect method involving the identification of pedons at regular intervals on random lines was used on both small and large areas. On the smaller estuarine marshes, transect lines 75 to 150 feet in length were run generally perpendicular to the stream with pedons observed every few feet. On larger estuarine marshes and out from the margin of the coastal marshes, transects of up to 1,000 feet were run with spacing of pedons as much as 100 feet apart. The grid method was also used, in sizes from 1/4-acres with 10-foot spacing of pedons to 2-acre grids with a 25- to 75-foot spacing.

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APPENDIX A

ANNOTATED SPECIES LIST OF VASCULAR PLANTS for NEW HAMPSHIRE TIDAL MARSHES AND DUNE AREAS

Note: This is not intended to be a complete list of the flora but contains those plants which are most frequently encountered and serve to characterize the various vegetational communities.

Scientific Name	Common Name	Description
Acnida cannabina L.	Water Hemp	A dioecious, erect, weedy, succulent, somewhat resembling Cannabis, which may grow 3-4 feet high. Frequent along muddy banks of creeks and ditches on the high marsh. Annual.
Ammophila breviligulata Fern.	Marram or Beachgrass	A coarse perennial, 2-3 feet high, with long spike-like panicle and widely creeping rhizomes. The major binding and stabilizing plant of sand dunes.
Arenaria peploides L.	Seabeach Sandwort	A fleshy, procumbent, spreading plant of dune areas. Forking, pale-green stems with darker green, fleshy, decussate leaves having small axillary flowers. Not common in this area.
Artemisia stelleriana Bess.	Dusty Miller	A common, matted perennial of the sand dunes, with whitish-gray densely pubescent leaves and ascending flowering stems.
Artemisia caudata Michx.	Wormwood	A biennial of dune areas and waste places. The 1-3 foot high leafy, flowering stems arising from a basal rosette of finely cut green leaves.
Aster subulatus Michx.	Annual Salt Marsh Aster	Occasional to frequent along edge and extending out on the high marsh. Somewhat fleshy stem and narrow linear leaves, green suffused with purple. Ray flowers purplish.
Aster tenuifolius L.	Perennial Salt Marsh Aster	Uncommon, northern limit of range, same habitat as A. subulatus. Stoloniferous, narrowly linear leaves. Ray flowers pale purple.
Atriplex glabriuscula Edmondston	Orach	Common along creeks and drainage ditches. Fleshy annual with thick triangular leaves. Of a stouter habit than A. patula.
Atriplex patula L. (vars.)	Orach	Very common annual along creeks and ditches and scattered throughout the marsh. Simple to much branching with highly variable leaf shape.
Bassia hirsuta (L.) Aschers.	Hairy Bassia	Bushy-branched annual closely resembling Suaeda spp. Found along strand line at edge of marsh. (Of Eurasian origin, first reported from N.H. by this author 1973).
Cakile edentula (Bigel.) Hook.	Sea-Rocket	Fleshy annual of the sand dunes. Flowers purplish, conspicuous 2-jointed seed pods (silicle). Young leaves and stems have horseradish flavor.
Carex scoparia Schkuhr		A sedge, common near edge of marsh especially adjacent to dune areas. Forming mats or tufts of slender yellow-green culms 1-3 feet high. Perennial.
Carex hormathodes Fern.		A sedge, usually wetter habitat than C. scoparia. Plants smaller and more densely tufted. Perennial.

Scientific Name	Common Name	Description
Cladium mariscoides (Muhl.) Torr.	Twig-Rush	Actually a sedge, but resembling a rush. A stoloniferous perennial occasionally forming large stands in brackish areas along edge of marsh. 2-3 feet high.
Distichlis spicata (L.) Greene	Spike Grass	Abundant, usually growing in association with Spartina patens but frequently forming pure stands. Pale green, leaves distinctly two ranked. Rigid erect perennial with deep, extensively creeping rhizome. Dioecious. Spikelets whitish, papery when mature.
Eleocharis halophila Fern. & Brack.	Salt Marsh Spike-Rush	Occasional in wet, saline ditches and depressions. Culms slender yellowish-green 1-1½ feet high. Loosely stoloniferous perennial.
Eleocharis parvula (R.&S.) Link	Spike-Rush	Very small, hair-like culms only ½-1½ inches high. Forming dense tufts or mats spreading over the mud in areas of moderate silt accumulation. Perennial with minute tubers on roots.
Eleocharis smallii Britt.	Small's Spike Rush	Similar in appearance to E. halophila except culms more firm and wiry and more densely tufted. Grows in fresh-brackish areas, often where upland stream flows into marsh.
Elymus virginicus L. (vars.)	Sea-Coast Wild Rye	Coarse perennial grass growing in tussocks with culms often over 3 feet high. Stiff, dense, whitish-green spike. Frequent along the upland edge of estuarine and some coastal marshes.
Euphorbia polygonifolia L.	Seaside Spurge	A prostrate, spreading, branching herb of sandy or gravelly beaches above high tide line and in hollows of sand dunes.
Gerardia maritima Raf.	Salt Marsh Gerardia	A fleshy-leaved annual with slender branching stem usually 4-8 inches high common on the borders of forb pannes on a Spartina patens marsh. Small but showy lavender to purplish flowers from mid-July-Sept.
Glaux maritima L. var. obtusifolia Fern.	Sea Milkwort	A low, leafy, fleshy, loosely ascending perennial with opposite leaves and tiny pink-lavender axillary flowers. Common along edges of marsh, growing among Spartina patens.
Hordeum jubatum L.	Squirrel-Tail Grass	Annual or biennial grass 12-18 inches high with nodding spike of pale green bristly spikelets, bouncing with the slightest breeze. Scattered on high marsh.
Hudsonia tomentosa Nutt.	Beach Heather	Dense, low-lying, 6-8 inches high, bushy heath-like perennial, often forming extensive mats in sand dune areas. Small leaves densely pubescent. Tiny sulphur yellow flowers May-July.
Iva frutescens L. var. oraria (Bartlett) Fern. & Grisc.	Marsh Elder or Highwater Shrub	A shrubby, woody member of the Compositae about 3-4 feet high. Found in N.H. on gravelly strands at the edge of the marsh in the Great Bay system and at one site in Portsmouth. Otherwise, it is disjunct between northeast Mass. and southwest Nova Scotia.

Scientific Name	Common Name	Description
Juncus balticus Willd. var. littoralis Engelm.	Baltic Rush	Common in sandy-peaty areas along the upland edge of the marsh. Slender, erect, terete culms 1-3 feet high spreading from an extensively creeping and forking rhizome.
Juncus canadensis J. Gay	Canadian Rush	Common in wet fresh-brackish areas at the border of the marsh. Tufted, stiffly erect culms to 3½ feet tall. Inflorescences often infected with insect galls.
Juncus gerardii Loisel.	Black Grass	Very abundant along the landward edges of the marsh either associated with Spartina patens or forming pure stands. Clumps out on the high marsh frequently indicate recently submerged sand hills. Culms slender, 12-18 inches high, inflorescence appears dark. Rhizomatous perennial.
Juncus greenei Oaks & Tuckerm.		Superficially may resemble J. gerardii. However, its typical habitat in this area is sand dunes, where it usually forms dense tufts.
Lathyrus japonicus Willd. var. glaber (Ser.) Fern.	Beach Pea	Fleshy perennial, commonly found around the border of dune areas and edge of marsh. Blue-violet flowers, leguminous pod fruit.
Lechea maritima Leggett	Pinweed	Herbaceous perennial of sand dune areas with overwintering rosette of densely pubescent leafy shoots. Flowering stem an inconspicuous upright panicle usually less than 12 inches high.
Limonium nashii Small	Sea Lavender or Marshy Rosemary	A thick rooted perennial of the high marsh and forb pannes. A slender much branched stem bearing numerous, delicate lavender flowers (July-Oct.) arises from a basal rosette of fleshy oblong leaves.
Lythrum salicaria L.	Spiked Purple Loosestrife	Tall, perennial with spikes of purple flowers, usually forming large stands along the border of brackish marshes or invading the high marsh in areas where natural drainage has been impeded. Presence of this plant often indicates the degradation of a viable salt marsh.
Myrica pensylvanica Loisel.	Bayberry	A stout, stiffly branched shrub of sand dune areas, usually 3-4 feet high. Leaves and whitish, waxy globular fruits very fragrant when crushed. Fruit source of wax for bayberry candles.
Panicum virgatum L. var. spissum Linder	Switchgrass	A common grass along the border of the marsh. Culms 3-4 feet high with loose panicles. Perennial with short rhizomes, usually forming dense tufts.
Phragmites communis Trin. var berlandieri (Fourn.) Fern.	Reed	Very tall grass forming extensive stands along the border of some marshes and brackish areas. Often to 10 feet high with large plumose terminal panicle. A perennial spreading extensively from rhizomes.
Pinus rigida Mill.	Pitch Pine	Scruffy, gnarled pine of sand dune areas. Needles 3 to a fascicle. Cones sessile to branch and often persisting on larger limbs, each cone scale with a sharp prickle.

Scientific Name	Common Name	Description
Plantago juncoides Lam. var. decipiens (Barneoud) Fern	Seaside Plantain	Deep rooted perennial with strongly ascending linear-lanceolate fleshy leaves. Flowering stalks exceeding leaves, inflorescence a densely crowded spike. Gravelly areas near edge of marsh and growing out of crevasses in rocks.
Plantago oliganthos R.&S.	Seaside Plantain	Similar to P. juncoides. However, leaves more fleshy. Flowering stalk usually not exceeding leaves, inflorescence not densely crowded. Grows on high marsh and in forb pannes. Young leaves a tasty vegetable either cooked or raw.
Polygonella articulata (L.) Meisn.	Jointweed	Common annual of the sand dune areas. Delicate, erect branching jointed stem with small linear leaves and many tiny white to rose color flowers.
Polygonum aviculare L.	Knotweed	Weedy annual of gravelly strands along the marsh. Prostrate spreading to loosely ascending jointed stems with blue-green linear leaves.
Polygonum ramosissium Michx.	Bushy Knotweed	Erect annual, frequently 2+ feet high, growing on the high marsh. Jointed stems, simple to much branching with linear leaves. The whole plant yellowish-green.
Potamogeton pectinatus L.	Sago Pondweed	Submergent aquatic of brackish ponds. Very fine (filiform) stems and leaves. Superficially resembles another more common aquatic, Ruppia maritima.
Potentilla anserina L.	Silverweed	Common on the high marsh especially along the edges. A perennial spreading by slender runners. Dark green, pinnate, serrate leaves with silvery-silky bloom beneath. Flowers bright sulfur yellow June-August.
Prunus maritima Marsh.	Beach Plum	A low densely branched shrub, usually less than 4 feet high of the dune areas. Flowers April-June before leaves. Leaves pointed with serrate margin, pubescent beneath. Fruit a small purple drupe Sept.-Oct.
Puccinellia maritima (Huds.) Parl.	Alkali Grass	A coarse, tufted perennial, about 2-3 feet high, scattered in clumps on the high marsh and occasionally forming nearly pure stands. Culms pale bluish-green. Leaves becoming involute. Ascending, spreading panicle.
Puccinellia paupercula (Holm) Fern. & Weath. var. alaskana (Scribn. & Merr.) Fern. & Weath.	Alkali Grass	Small, very densely tufted to matted, flowering culms usually less than 12 inches high with 3-4 inch leaves at base. Scattered in highly saline pannes with Salicornia spp.
Quercus alba L.	White Oak	A large tree, common along the border of the marsh and especially characteristic of "marsh islands", rock outcrops or glacial formations which have been cut off from the shoreline by marsh development. Leaves deeply lobed with rounded tips; flaky light-colored bark.
Quercus bicolor Willd.	Swamp White Oak	Occasional along the border of the marsh. Leaves obovate with sinuate margin, the underside often whitish-downy. Bark light colored and flaky.

Scientific Name	Common Name	Description
Ranunculus cymbalaria Pursh	Seaside Crowfoot	Frequent on muddy creek banks especially of our estuarine marshes. A small fleshy annual with long petioled rounded leaves and small bright yellow flowers. Somewhat tufted often with filiform stolons.
Rosa rugosa Thunb.	Salt Spray Rose	Frequent along the coast in clumps or small thickets. Introduced, spread from cultivation. Coarse dense growth, the canes very prickly and bristly. Dark green leaves. Flowers showy with many deep red petals (also, occasional white form). Fruit a large brick-red hip up to 1 inch in diameter.
Rosa virginiana Mill.	Virginia Rose	A common and beautiful rose inland as well as along the borders of the salt marsh. Often forming dense thickets. Canes red. Leaves thin and flat. Corymbos of pink few petaled flowers. Fruit a red hip usually less than ½ inch diameter.
Ruppia maritima L. (vars.)	Ditch Grass	A submergent aquatic with filiform, forking stem and very slender leaves. Closely related to pondweeds and of wide distribution. Commonly occurring in pond holes and ditches on the high marsh. A variable species with a wide range of salinity tolerances.
Sanguisorba canadensis L.	Canadian Burnet	A tall perennial, occasional along the border of the marsh. Compound leaves with many serrate leaflets. The inflorescence whitish cylindrical spike 2-6 inches long.
Salicornia bigelovii Torr.	Dwarf Glasswort	The smallest of the glassworts. An annual with a simple stem or with few ascending branches usually less than 6 inches high. Cylindric, succulent, with jointed habit characteristic of the group. Occasional to frequent in highly saline pannes on the high marsh.
Salicornia europaea L.	Glasswort or Samphire	An erect annual glasswort. By far the most common in pannes or scattered on the high marsh, along ditches, etc. Simple to profusely branching stem. Green succulent, turning flaming red in autumn.
Salicornia virginica L.	Perennial or Woody Glasswort	Forming extensive mats, spreading from forking rhizome on the high marsh, especially near the dune areas in Seabrook. It apparently reaches the northern limit of its range on our marshes. Does not turn red in autumn.
Scirpus americanus Pers.	Three-Square	A slender sedge with sharply triangular culms about 3 feet high. Spreading from rhizomes in wet brackish areas. Inflorescence cluster of small spikelets appearing to be sessile on culm.
Scirpus acutus Muhl.	Hard Stem Bulrush	A tall sedge with olive-green terete culms frequently to 6 feet or more. Occasionally in large stands in wet areas along the border of the marsh. Stout, scaly horizontal rhizome.
Scirpus atrovirens Willd.		A sedge of inland meadows and bogs, but also occurring in wet, fresh to brackish areas along our coast. Distinctly triangular leafy culms with umbelliform inflorescence.

Scientific Name	Common Name	Description
Scirpus cyperinus (L.) Knuth	Wool-Grass	A sedge forming dense tussocks of nearly terete culms along fresh-brackish borders of the marsh. Umbellate inflorescence of spikelets distinctly wooly at maturity.
Scirpus maritimus L. var. *fernaldii* (Bickn.) Beetle	Salt Marsh Bulrush	A coarse sedge with triangular leafy culms 3-4 feet high, often forming extensive stands along the border of the marsh. Inflorescence of clustered, elongate spikelets on rays.
Scirpus paludosus Nels.	Bayonet-Grass	A pale green sedge usually less than 3 feet high which is most common in very wet pannes and "rotten spots" on the marsh. Dense cluster of spikelets.
Scirpus robustus Pursh		Similar to *S. maritimus*, only of a more vigorous stature and with spikelets being distinctly conical-ovoid. Less common but occurring in pure stands at a number of sites.
Scirpus validus Vahl	Great or Soft Stem Bulrush	Resembling *S. acutus*, only with easily compressed pale green culms and smaller spikelets. Forms large stands, spreading by horizontal rhizomes along border of marsh.
Smilax rotundifolia L.	Greenbriar	A tough, prickly, woody vine with roundish leaves and blue-black berries when in fruit. Forming dense, impenetrable thickets on "marsh islands" or along border of marsh.
Solidago sempervirens L.	Seaside Goldenrod	Stout perennial with fleshy, smooth, entire, oblong leaves. Highly variable shape of inflorescence (loosely spreading to spike-like) of yellow flowers July-Nov. Common along edge of marsh often extending out on high marsh.
Spartina alterniflora Loisel.	Salt Water Cord Grass or Thatch	One of the two major vascular plants of the salt marsh. A tall, coarse, rhizomatous grass with appressed flowering spikes. Occurs throughout the intertidal zone and along creeks and larger ditches wherever there is strong tidal influence. A dwarf form frequently occurs in poorly drained areas not regularly flooded or removed from a drainage system.
Spartina patens (Ait.) Muhl.	Salt Meadow Grass	The dominant species of New Hampshire tidal marshes. Forms the high marsh peat and salt meadow. A slender wiry grass which is blown in tousled cowlicks. Inflorescence a raceme of purplish spikes. Locally known as salt hay.
Spartina pectinata Link	Fresh Water Cord Grass	A tall, graceful grass which occurs along the border of the marsh and well back along water courses in drier situations than the other two species. Hard, scaly rhizomes. Comb-like inflorescence. Leaves with rough feeling (scabrous) margins.
Spergularia canadensis (Pers.) Don	Sand Spurrey	Small annual with nearly smooth spreading ascending to prostrate stems and fleshy leaves. Commonly occurs along sandy strands at the edge of the marsh and near dune areas.

Scientific Name	Common Name	Description
Spergularia marina (L.) Griseb.	Sand Spurrey	Very similar to S. canadensis only more succulent or fleshy and with fine gland hairs on stem. Common throughout the high marsh especially along the rim of creek banks and drainage ditches.
Suaeda linearis (Ell.) Moq.	Sea Blite	Probably the most common of the Suaedas in New Hampshire, or at least the most easily distinguishable. An erect or ascending annual, green to reddish, fleshy with strongly keeled sepals. Occurs along strand lines and out on the high marsh. Especially along the edges of creeks or drainage ditches. Note: All Suaedas have inconspicuous flowers sessile in the axils of leaves or leafy bracts.
Suaeda maritima (L.) Dumort.	Sea Blite	A low, decumbent annual, somewhat spreading, green, often with whitish bloom, more fleshy, succulent than S. linearis with rounded sepals. Frequent along strand areas and on the high marsh near ditches.
Suaeda richii Fern.	Sea Blite	A nearly prostrate, spreading annual of the strand line and along creeks and ditches. Leaves dark green, stems green to reddish. This is a problematic group, not easily distinguished by superficial characteristics.
Toxicodendron radicans (L.) Kuntze	Poison Ivy	This common plant with 3 shiny leaflets familiar to all occurs either as a sprawling, climbing, or upright bushy shrub. Often becoming exceptionally vigorous in certain areas along the border of the marsh and in dune areas.
Triglochin maritima L.	Seaside Arrow Grass	Not a grass at all, but in a separate family. A common perennial of forb panne associations on the high marsh. Rootstock covered with persistant leaf bases. Flowering stocks up to 3 feet high but usually shorter. Rush-like leaves. Small plants sometimes confused with Plantago spp. However, leaves are distinct.
Typha angustifolia L.	Narrow-Leaved Cat-Tail	Leafy stems 3-5 feet high forming dense, extensive colonies in brackish areas along the border of the marsh. The slender, dark brown pistillate portion of the spike usually separated by a space from the staminate part above.
Typha latifolia L.	Broad-Leaved or Common Cat-Tail	More robust and taller than T. angustifolia with larger flowering spikes, the pistillate and staminate portions being contiguous. Common in fresh to slightly brackish areas near the marsh. However, either one species or the other is markedly dominant in a particular area, the narrow-leaved cat-tail in the more brackish habitats.
Zannichellia palustris L.	Horned Pondweed	A submergent aquatic with slender branching stems and linear filiform leaves bearing clusters of 4 curved fruits. Frequent in small estuaries at the upper reaches of the tide.

Scientific Name	Common Name	Description
Zostera marina L. var. *stenophylla* Aschers. & Graebn.	Eelgrass or Wrack	A submergent aquatic of bays, marsh creeks, and estuaries. Marine. Creeping, jointed rhizomes with branching stems and slender ribbon-like leaves. Flowers born on a spadix hidden within a narrow spathe leaf.

APPENDIX B

PROFILE DESCRIPTIONS--1970 Tidal Marsh Soils Study
Near Portsmouth, New Hampshire

Soil: Map Symbol - 397
Classification: Typic Sulfihemists
Location: Rockingham County, N.H.; town of Seabrook; Public Service Company of N.H. property; 1800 feet east of the end of Rock Road. Seabrook Marsh. Site located on photo no. DQW-9K-160.
Topography: Nearly level tidal flats bordering Atlantic Ocean coastline.
Drainage: Very poorly drained.
Vegetation:
Sampled by: E. Pedersen, S. Holzhey, L. Garland, N. Peterson, P. Sutton, S. Pilgrim, R. Bond, R. Rutherford. August 4, 1970.
Description by: R. Bond and S. Pilgrim.
Soil No.: S70NH-10-1. Beltsville lab nos.: 70B361-70B370.
Remarks: Colors for moist soil. pH determined with a portable pH meter and glass electrode. Samples obtained from a pit to a depth of 107 cm and with a McCauley peat sampler below this depth. The layers at 178-211 cm and 211-236 cm were combined for sampling.

Oa1 0-12 cm (0-5 in.). Very dark grayish brown (2.5Y 3/2); very dark grayish brown (2.5Y 3/2) rubbed organic material with some mica; 40 percent fiber, 10 percent rubbed; massive; nonsticky; many fine roots; sodium pyrophosphate extract color light gray (10YR 7/1); fine herbaceous fibers; pH in water, initial 6.25, dried 18 days 6.2 ; clear and smooth boundary.

Oe1 12-23 cm (5-9 in.). Dark grayish brown (10YR 4/2) organic material with some fine sand and mica; 80 percent fiber, 25 percent rubbed; massive, slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine and some medium herbaceous fibers; pH in water; initial 6.15, dried 18 days 6.1 ; clear and smooth boundary.

Oe2 23-28 cm (9-11 in.). Very dark gray (10YR 3/1) organic material with some lenses of fine and very fine sand and mica; 70 percent fiber, 35 percent rubbed; massive; slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine herbaceous fibers; pH in water, initial 6.12, dried 18 days 5.9 ; clear and smooth boundary.

Oi1 28-44 cm (11-17 in.). Dark olive gray (5Y 3/2) organic material with some small lenses of fine and very fine sand and some mica flakes; 85 percent fiber, 50 percent rubbed; massive; slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine herbaceous fibers; pH in water 6.08, dried 18 days 5.7 ; clear and smooth boundary.

Oi2 44-86 cm (17-34 in.). Olive gray (5Y 4/2); dark olive gray (5Y 3/2) rubbed organic material intermixed with small amounts of silt; 95 percent fiber, 80 percent rubbed; massive; slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine herbaceous fibers; pH in water 6/05, dried 18 days 4.1 ; clear and smooth boundary.

Oe3 86-107 cm (34-42 in.). Olive gray (5Y 4/2) organic material; 70 percent fiber, 15 percent rubbed; massive; slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine herbaceous fibers; pH in water, initial 6.12, dried 18 days 3.2 ; clear and smooth boundary.

Oi3 107-178 cm (42-70 in.). Dark olive gray (5Y 3/2) organic material; 70 percent fiber, 40 percent rubbed; massive; slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine herbaceous fibers; pH in water; initial 6.12; dried 18 days 3.1 ; clear and smooth boundary.

Oi4 178-211 cm (70-83 in.). Dark olive gray (5Y 3/2) organic material; 70 percent fiber, 40 percent rubbed; massive; nonsticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine herbaceous fibers; black (5Y 2/1) organic band occurs in upper 3 in.; pH in water, initial 5.85, dried 18 days 2.6 ; clear and smooth boundary.

Oe4 211-236 cm (83-93 in.). Black (5Y 2/2) organic material; 70 percent fiber, 25 percent rubbed; massive; slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine herbaceous fibers; olive gray (5Y 5/2) silt band occurs in upper 2 in.; pH in water, initial 5.85, dried 18 days 2.6 ; clear and smooth boundary.

Oe5 236-305 cm (93-120 in.). Dark olive gray (5Y 3/2); 70 percent fiber, 30 percent rubbed; massive; slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine and very fine herbaceous fibers; olive gray (5Y 4/2) silt band occurs in upper 2 in.; pH in water, initial 6.0; dried 18 days 3.0 ; clear and smooth boundary.

IIC 305-343 cm (120-135 in.). Very dark grayish brown (10YR 3/2) sand; massive; nonsticky; no roots; no coarse fragments; black (N 2/) silt band occurs in upper 3 in.; pH in water, initial 6.0; dried 18 days 3.5 .

Soil: Map Symbol - 397
Classification: Typic Sulfihemist, fibric subsurface tier
Location: Rockingham County, N.H.; town of Rye; R. L. Brown property on NH Route 1-A; approximately 850 feet west of homestead of R. L. Brown. Rye Marsh. Site located on unnumbered photo (aero-services flight).
Topography: Nearly level tidal flats bordering Atlantic Ocean coastline.
Drainage: Very poorly drained.
Vegetation:
Sampled by: E. Pedersen, S. Holzhey, L. Garland, S. Pilgrim, R. Bond, R. Rutherford. August 4, 1970.
Description: R. Bond, C. H. J. Breeding.
Soil No.: S70NH-10-2. Beltsville lab nos.: 70B371-70B376.
Remarks: Sampled with a McCauley peat sampler. Field pH determined with a portable pH meter and a glass electrode.

Oi1 0-51 cm (0-20 in.). Olive gray (5Y 4/2), dark olive gray (5Y 3/2) rubbed organic material; 85 percent fiber, 75 percent rubbed; massive; nonsticky; many fine roots; sodium pyrophosphate extract color white (10YR 8/1); fine and some medium herbaceous fibers; pH in water, initial 5.4, dried 18 days 3.2 ; clear and smooth boundary.

Oi2 51-109 cm (20-43 in.). Dark olive gray (5Y 3/2), same rubbed organic material; 75 percent fiber, 70 percent rubbed; massive; nonsticky; sodium pyrophosphate extract color white (10YR 8/1); pH in water, initial 6.2, dried 18 days 3.8 ; clear and wavy boundary.

Oe1 109-135 cm (43-53 in.). Black (5Y 2/2), same rubbed organic material; 45 percent fiber, 20 percent rubbed; massive; nonsticky; sodium pyrophosphate extract color white (10YR 8/1); fine, herbaceous fibers; pH in water, initial 6.4, dried 18 days 4.1 ; clear and smooth boundary.

Oi3 135-183 cm (53-72 in.). Black (5Y 2/2), same rubbed; 70 percent fiber, 50 percent rubbed; massive; nonsticky; sodium pyrophosphate extract color white (10YR 8/1); fine, herbaceous fibers; pH in water, initial 6.3, dried 18 days 3.8 ; clear and smooth boundary.

Oi4 183-244 cm (72-96 in.). Dark brown (7.5YR 3/3), very dark grayish brown (10YR 3/2) rubbed; 75 percent fiber, 55 percent rubbed; sodium pyrophosphate extract color white (10YR 8/1); fine and some medium herbaceous fibers; pH in water, initial 6.2, dried 18 days 4.2 ; clear and wavy boundary.

Oi5 244-305 cm (96-120 in.). Black (5Y 2/2), very dark grayish brown (10 YR 3/2) rubbed; 75 percent fiber, 55 percent rubbed; massive; nonsticky; sodium pyrophosphate extract color white (10YR 8/1); fine herbaceous fibers; pH in water, initial 6.2, dried 18 days 3.9 .

Soil: Map Symbol - 597
Classification: Terric Sulfihemists, over silt, fibric subsurfa ce tier
Location: Rockingham County, N.H.; town of Seabrook on the property of Public Service Co. of N.H.; 990 feet northeast of the end of Depot Road. Seabrook marsh. Site located on photo no. DQW-9K-160.
Topography: Nearly level tidal flats bordering Atlantic Ocean coastline.
Drainage: Very poor.
Vegetation:
Sampled by: E. Pedersen, S. Holzhey, L. Garland, N. Peterson, P. Sutton, S. Pilgrim, R. Bond, R. Rutherford. August 5, 1970.
Description by: R. Bond and S. Pilgrim.
Soil No.: S70NH-10-3. Beltsville lab nos.: 70B377-70B382.
Remarks: Colors for moist soil unless otherwise indicated. Sampled to 122 cm from pit and with a McCauley peat sampler below this depth. Field pH determined with a portable pH meter and glass electrode.

Oi1 0-13 cm (0-5 in.). Dark olive gray (5Y 3/2), same rubbed organic material; 95 percent fiber, 80 percent rubbed; massive; nonsticky; many fine and medium roots; sodium pyrophosphate extract color light gray (10YR 7/1); many fine and medium herbaceous fibers; pH in water, initial 5.1, dried 18 days 4.1 ; clear smooth boundary.

Oi2 13-28 cm (5-11 in.). Dark olive gray (5Y 3/2), same rubbed organic material; 95 percent fiber, 80 percent rubbed; massive; nonsticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine medium and coarse herbaceous fibers; pH in water, initial 6.4, dried 18 days 3.7 ; clear smooth boundary.

Oi3 28-61 cm (11-24 in.). Dark olive gray (5Y 3/2), same rubbed organic material with some silt and a few mica flakes; 85 percent fiber, 70 percent rubbed; massive; slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/1); many fine and medium, with a few coarse herbaceous fibers; pH in water, initial 6.6, dried 18 days 3.0 ; clear smooth boundary.

Oi4 61-81 cm (24-32 in.). Dark olive gray (5Y 3/2), same rubbed organic material with some mica and silt and fine sand; 85 percent fiber, 70 percent rubbed; massive; slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/1); fine and medium with many coarse herbaceous fibers; pH in water, initial 6.7, dried 18 days

2.7 ; clear smooth boundary.

Oe1 81-102 cm (32-40 in.). Dark olive gray (5Y 3/2), same rubbed organic material with some silt and a few mica flakes; 50 percent fiber, 25 percent rubbed; massive; slightly sticky; sodium pyrophosphate extract color light gray (10YR 7/2); many fine with few coarse herbaceous fibers; pH in water, initial 6.6, dried 18 days 3.8 ; clear smooth boundary.

IIC 102-183 cm (40-72 in.). Dark gray (5Y 4/1); silty clay loam; massive; slightly sticky; few fine and medium herbaceous fibers; pH in water, initial 6.9, dried 18 days 3.3 ; a few clam shells very pale brown (10YR 8/2) throughout horizon.

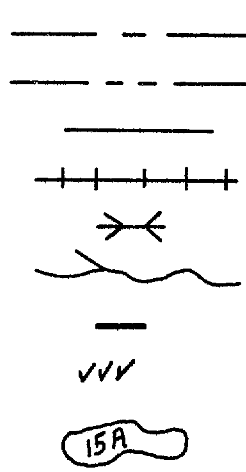
MAP SEQUENCE

9K-120
9K-122
9K-124
9K-126
9K-135
9K-137
9K-158
9K-160
9K-162
9K-170
9K-172
9K-174
9K-176
9K-196
9K-198
9K-200
10K-5
10K-8
10K-11
10K-13
10K-23
10K-25
10K-26
7M-18
7M-28
7M-30
7M-32
7M-34
11M-98
11M-100

SOIL LEGEND

Symbol	Name
15A	Scarboro fine sandy loam, 0 to 3 percent slopes.
61B	Hollis-Charlton very rocky fine sandy loams, 0 to 8 percent slopes.
397	Typic Sulfihemists, organic materials thicker than 50 inches.
497	Terric Sulfihemists over sand, organic materials 16 to 50 inches thick overlying sandy materials.
597	Terric Sulfihemists over silt, organic materials 16 to 50 inches thick overlying silty materials.
697	Lithic Sulfihemists, organic materials 16 to 50 inches thick overlying bedrock.
797	Typic Sulfaquents, organic materials less than 16 inches thick overlying sandy materials.
997	Sulfihemists, surface soil materials with low salt, organic materials thicker than 50 inches, or 16 to 50 inches thick overlying sandy or silty material.

MAP SYMBOLS



State Boundary

County Boundary

Road

Railroad

Bridge

Stream

Dam

Rock Outcrop

Soil Symbol and Boundary

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Document ID: Soil Survey of New Hampshire

31 Images

Page #: Between Soil Legend & Back Cover

SOIL SURVEY OF NEW HAMPSHIRE
TIDAL MARSHES

Major field work for this soil survey was completed in 1973. Soil names and descriptions were given approval in 1974 for use in this special publication. Soil names are subject to change in subsequent soil survey publications of the National Cooperative Soil Survey for either Rockingham or Strafford Counties. Unless otherwise indicated, statements in this publication refer to conditions in the area in 1973. This survey was made cooperatively by the Soil Conservation Service and the New Hampshire Agricultural Experiment Station with financial assistance from the New England Regional Commission. It is part of the technical assistance furnished by the Soil Conservation Service to the Rockingham and Strafford County Conservation Districts.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

This survey includes only the significant areas of tidal marsh soils in New Hampshire. Small areas located along estuaries and other areas have not been included. Users may wish to refer to published soil surveys of Rockingham County (1959) and Strafford County (1973) for information on mineral soils (including dune areas) that adjoin the tidal marshes.